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CIVIL ENGINEERING

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New Design for East Anchorage of George Washington Bridge and Viaduct Arch Over Riverside Drive
Although the Bridge Was Opened to Traffic in 1931, the Structures on the New York Side Were Only Partly Completed

Volume 8 *Number 2*

FEBRUARY 1938

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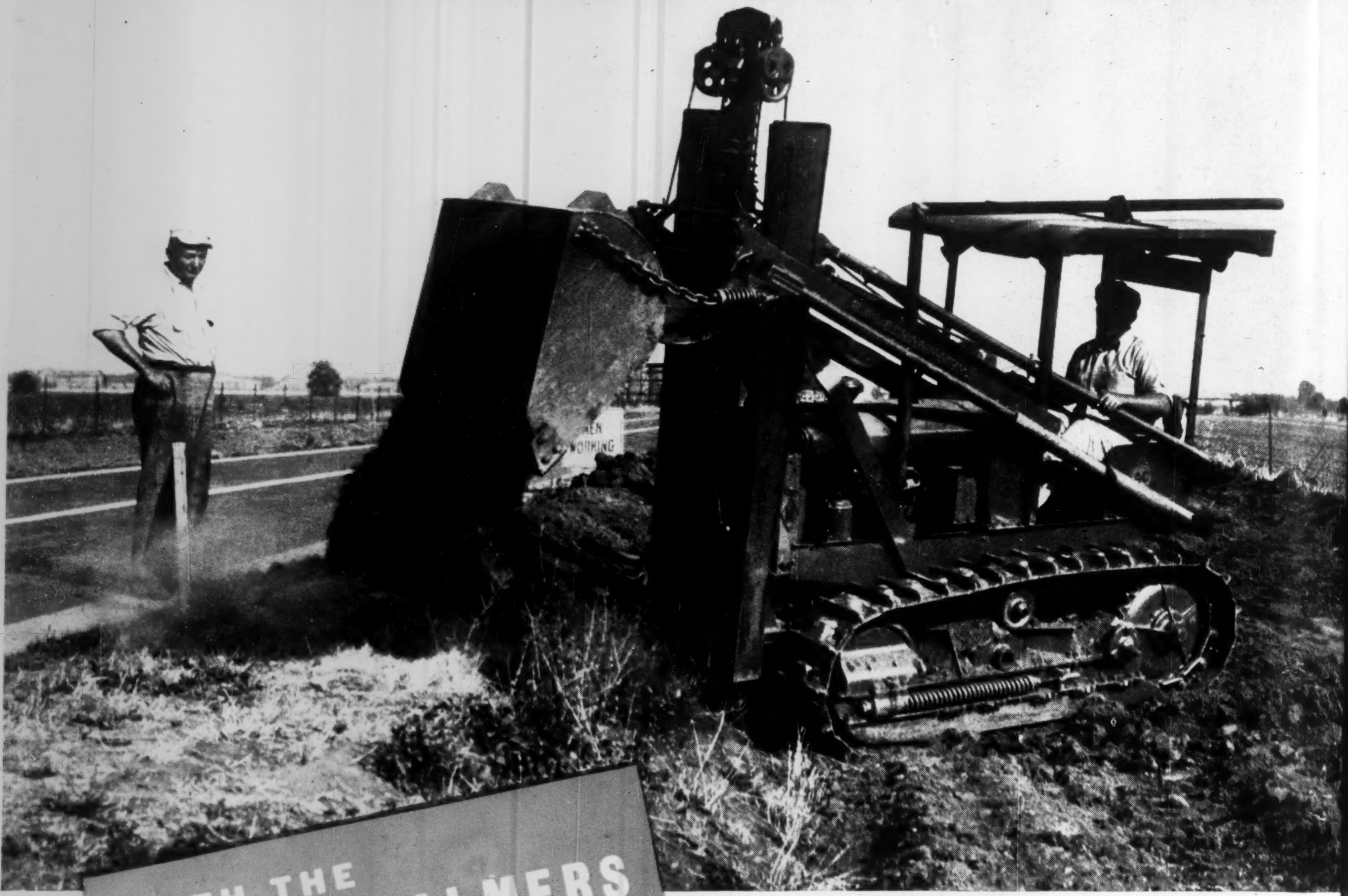

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Among Our Writers

W. W. Horner was for 15 years chief engineer of sewers and paving for St. Louis. His practice as municipal and consulting sanitary engineer has included constructing many large sewer systems. In the fall of 1937 he became professor of municipal and sanitary engineering at Washington University. He served as Director of the Society in 1933–1935.

Aymar Embury II, educated both as a civil engineer and as an architect, has practiced architecture for over 35 years. In addition to his private practice he has served as consultant to the Port of New York Authority, the New York City Department of Parks, and the Triborough Bridge Authority, and is the author of numerous articles on a wide range of subjects.

Mortimer E. Cooley retired as dean of the colleges of engineering and architecture at the University of Michigan in 1928, after a lifetime devoted to engineering teaching and administration.

Walter E. Kroening served for 14 years in various capacities with the Milwaukee Sewerage Commission, including 6 years as senior engineer in charge of designs. Since January 1936 he has been with the Resettlement Administration, Department of Agriculture, first as sanitary engineer and at present as chief designing engineer in charge of planning utilities for the Greendale project.

Frank L. Dieter has had 16 years' broad experience in municipal engineering work, principally in the design of water and sewerage systems, sewage-treatment and water-softening plants, paving, and city planning. He has served as commissioner of public works of Wauwatosa, Wis., and civil engineer for the Greendale housing project, and is now with H. C. Webster, consulting engineer, Milwaukee, Wis.

Gene Abson graduated in chemistry at Wabash College in 1920. Since that time he has served with the Chicago Testing Laboratory (formerly the Chicago Paving Laboratory), where he is now chief chemist. He is vice-president of the Association of Asphalt Paving Technologists, and has written numerous articles on bituminous materials and pavement construction, as well as on methods of testing bituminous materials.

W. L. Chadwick for 10$^1/_2$ years was in charge of field engineering for the construction of tunnels, a dam, and a power plant (and later transmission engineer) on the Big Creek–San Joaquin project of the Southern California Edison Company, which organization he rejoined as civil engineer in October 1937. From 1931 to 1937 he was engaged on general design, estimates, and specifications for the Colorado River Aqueduct.

G. E. Archibald served as a second lieutenant in the British Royal Air Force during the World War. Beginning in 1923, he has spent 13 years as field engineer on various large California hydroelectric, sand-filter plant, and gas pipeline construction projects. Since 1931 he has been engaged on the Colorado River Aqueduct, principally as resident engineer on canal and conduit construction.

H. O. Hill has served with the U. S. Soil Conservation Service since 1931. During latter years he has been chief engineer of the Elm Creek watershed project, assistant to the field representative on soil conservation research, and (since July 1937) project leader of soil conservation investigations at the Blackland station. The present article was developed from an address given at the May 2, 1935, meeting of the Texas Section.

Volume 8 Number 2

February 1938

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

Entered as second class matter September 23, 1930, at the Post Office at Easton, Pa., under the Act of August 24, 1912, and accepted for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized on July 5, 1918.

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American Society of Civil Engineers

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CIVIL ENGINEERING

Published Monthly by the
American Society of Civil Engineers
(Founded November 5, 1852)
Publication Office: 20th and Northampton Streets, Easton, Pa.
Editorial and Advertising Departments:
33 West 39th Street, New York

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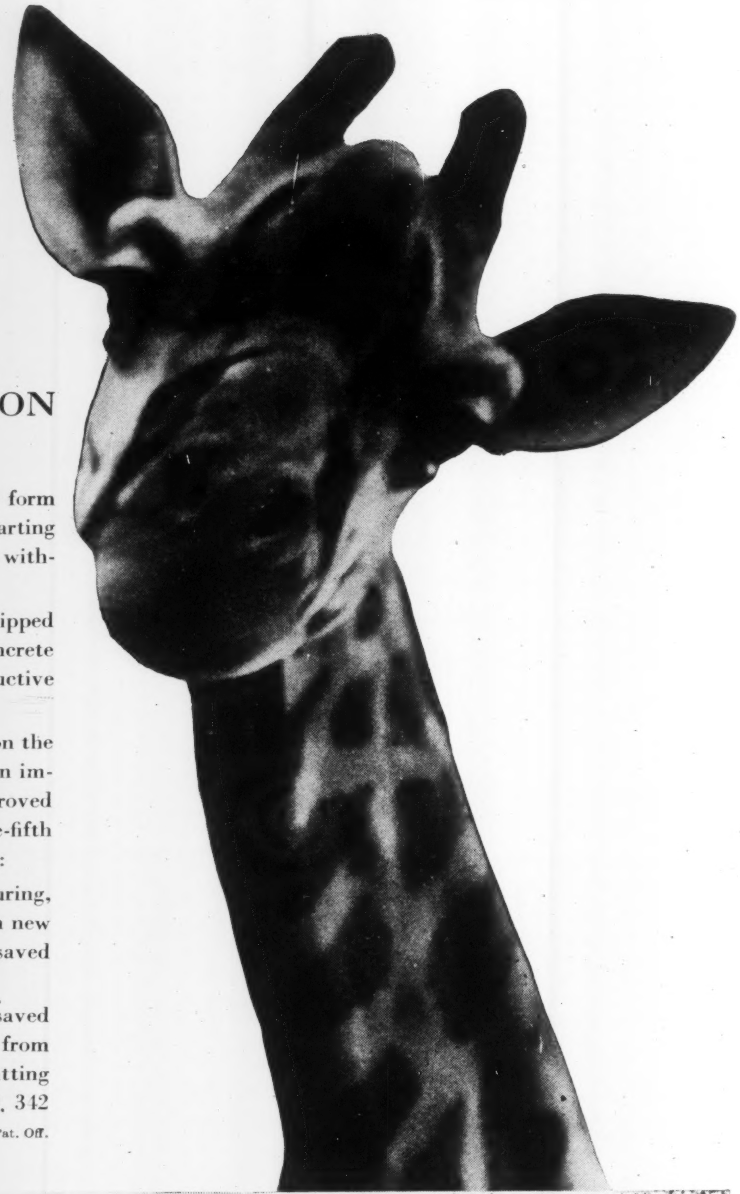

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Engineers and Economics

Modern Society Poses a Difficult Task for the Profession

By W. W. HORNER

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CONSULTING ENGINEER, ST. LOUIS, MO.

THERE are three conditions under which the engineer comes in contact with the economic phase of engineering problems. As adviser to a private client he may or may not find it incumbent to offer economic advice. Similarly, the responsible engineer in public service may find it necessary to express an opinion on, or even to attempt to secure support for, certain economic possibilities. Finally, the engineering profession as a whole is apparently expected to have opinions and to advise, in an increasing amount, on matters of public policy in connection with public works and related problems.

The Private Client.~It is frequently assumed that the engineer in his contact with private clients has developed a complete technique for handling economic questions. If we recognize engineers as investment experts in the various fields of their activity, it is obviously part of their duty to advise clients as to the economic propriety of a proposed project and to suggest alternate designs and plans where a more economic solution is possible, and a better investment may thus be secured. Often, however, the engineer is called in only for technical service, and his influence in matters of economy cannot extend beyond the specialization in which he is working.

Clearly, therefore, the engineer's responsibilities in private work depend, in the first instance, upon the restrictions of his engagement, but must necessarily be limited also by the experience, knowledge, and vision of the individual. The client may, and often does, engage the services of several engineers differently qualified; but commonly no one of them will be able to assume responsibility for the economic propriety of the project as a whole.

The Public Service.~In the field of public service, where engineers occupy positions of responsibility as administrators or advisory consultants, they are continually engaged with the economic phase of engineering projects and of progress. They are having to assume a wide responsibility and a major part in molding public opinion along economic lines, under conditions where many of the factors are in the intangible class, and often when proposals must be evolved in the midst of confused public reaction and political implications.

They must give full weight to the natural urge for better conditions of living and to the growing esthetic appreciation, but must maintain a due regard for the willingness and ability of the population to pay the bill.

Public Works.~There is, finally, a growing feeling of responsibility, on the part of engineers, for a better-planned coordination of public programs and for more complete planning in any one functional phase before accepting the economic propriety of particular projects. Undoubtedly we can all recall examples of individual water-development projects economically sound with respect to a specific purpose, or area, but definitely not in the public interest on the basis of a wider geographical examination or the consideration of other functional uses.

It is with respect to the Federal Public Works program, in its economic phase, that we are faced with the strongest differences of opinion and the greatest mental confusion, probably because it represents a mingling of several types of economic proposals, and in many projects these types are not readily distinguishable. It appears to amalgamate programs resting on different economic theories.

Divergent Viewpoints.~The most common objection voiced by engineers to this program is the failure to distinguish in it between projects of inherent economic soundness, using our older definition, and those that depend to a considerable degree for their justification on their "pump-priming" possibilities, and their availability for unemployment relief. Expressions from two members of the Society are particularly pertinent.

First, there is the statement of J. K. Finch, M. Am. Soc. C.E., in the December 1936 CIVIL ENGINEERING: "At one end of the scale of public undertakings we have works that are capable of reasonably strict engineering-economic analysis. . . . At the other end of the scale is the purely social undertaking, possessing, perhaps, some remote and intangible economic implications, but primarily a humanitarian work, and resting, therefore, on public opinion, on social philosophy, and on humanitarian ideals. . . . The engineer, however, has no fault to find with such works per se. What he objects to is the policy of bringing such projects forward in the false habiliments of economic works, and then expecting him to justify them on the only basis which is humanly possibly—namely, tangible, economic values."

Second, we have the view of D. C. Coyle, M. Am. Soc. C.E., in his book, *The Irrepressible Conflict:* "But since no individual dares to tackle his own deficit by spending enough to bring back prosperity, the Government has to act as a general spender to lift the national income in depression and to support it in prosperity. . . . The more of this kind of spending there is, the more market there will be for business, the more men will be actively employed, and the more wealth will be created. The creation of wealth, whether it be shoes or education or just the widespread feeling of economic security, is surely not extravagance."

An Intermediate Position.~Obviously, the reconciliation of these opinions will be a difficult matter. Possibly the first approach to an acceptable statement is one by Dr. Simeon E. Leland in the December 1936 report of the National Resources Committee on "Public Works Planning": "The primary benefits are those which distinguish productive from unproductive improvements. They denote public assets. It is the ability of expenditures of this type to satisfy collective or social needs which gives them a fundamental economic justification. Mere spending does not necessarily fulfill this requirement. . . . One of the prime advantages of a public works program as a stabilization device is the fact that it tends, with the wise selection of projects, to confer upon society valuable community assets, at the same time promoting economic stabilization. The better the projects selected, the more lasting will be the permanent benefits from the program. . . . To say that these secondary economic effects in themselves constitute a valid basis for public works may be to argue the economy of waste or to create a boondoggler's paradise. The public cannot be satisfied with mere expenditure of national resources productive solely of stabilization effects. Until the list of necessary improvements and desirable outlays is exhausted there is no place for a mere spending program."

Here we find the phrase "productive improvement—public assets—the satisfying collective or social needs giving fundamental economic justification," which seems the closest approach in this report to an attempt at a definition of economic soundness. But, here it should be noted that this refers in some degree to a public works program treated primarily as a device for economic stabilization and not necessarily or entirely involving a group of projects economically sound in other respects.

The Engineering Profession.~In the confused condition of our economic thought, can we expect the engineering profession to have a clear idea of what constitutes real economy? Social economic writers, charging our recent distress to technological developments, suggest that the engineer, who has been responsible for them, should be prepared to find a cure.

The engineer is continually being told that he is a natural leader in the economic field, but that his present generation lacks training in social thinking. The latter, many engineers will admit, and will question the propriety of their being chosen as leaders in this economic issue. Can the members of the profession expect to become sufficiently free from the pressure of technical work to be able to develop a broader economic philosophy?

But, the engineering profession is today in the most critical position of its whole history. The old firm economic foundation has been badly jarred. Efforts towards the economic evaluation of social needs are still of an elementary character. In this state of mental and moral distress, its members are being called upon to make recommendations and decisions of the greatest importance.

Still the idea of easy spending is prevalent and recent emergencies have produced a state of public hysteria. In the face of this situation, there need be no fear for the continuing high standard of conduct of the individual engineer dealing with a personal client; he will continue to give something more than the situation requires. It is on the men in public service that the crisis rests most heavily. They are, after all, human beings. The home town, the home state, and the home valley are obsessed with the idea that easy money can be had—"Why not for the home project?" Equally, the established technical services of the state and nation are aware that big programs in their particular fields may result in their becoming bigger and better bureaus and commissions, a situation likely to have a possibly subconscious effect on their economic philosophy.

Constant and Increasing Responsibility.~If this period passes without his having been guilty of more than those minor lapses which human frailty would normally contribute, the engineer's responsibility for economic phases of engineering work will thereafter continue to increase whether or not he desires it. It will have to come about gradually, but continuously, as he increases and broadens his conception of a sound economy that will recognize social values. Engineering schools and engineering societies will stress more and more the importance of self-education in this field. The responsibility will continue to be exercised most effectively as it is today, not primarily by the public expression of an organized professional body, but through the definite application of more and more rational consideration to the matters for which each engineer is individually charged, through a somewhat more definite demonstration from day to day of his ability to pass on more than the mere technical phases of the work, and through a continuing and further increasing respect for the engineer by the public for those characteristics for which he is now best known. And when the profession has arrived at a new and proper engineering opinion of what constitutes "social-economic" soundness, and is convinced of the reasonableness of the result, it may expect to have to exercise all the persuasion and ingenuity of which it is capable, for as Justice Holmes has expressed it, "I hate to discourage the belief of a man in reason. I believe in it with all my heart, but I think that its control over the actions of men, when it comes against what they want, is not very great "

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Volume 8

CIVIL ENGINEERING

February 1938

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Number 2

Esthetics of Bridge Anchorages

Applying Architectural Principles to Triborough, George Washington, and Whitestone Spans

By Aymar Embury II
Member American Society of Civil Engineers
Consulting Architect, New York, N.Y.

With increase in the number of long-span suspension bridges, the question of the esthetic design of anchorages has recently come to the fore. In the accompanying article Mr. Embury discusses from an architectural viewpoint anchorage design for two large bridges now in place in or contiguous to the city of New York, and a third now under construction. In the case of the Triborough Bridge, the function of the anchorages as counterpoises to the weight of the span was emphasized by their shape and surface treatment. The anchorages for the Whitestone Bridge will approximately take the form of the cables as they bend around the rocker arms and enter the concrete, with forward sides nearly perpendicular to the slope of the cables. The George Washington Bridge offers an entirely different problem because of the absence of sloping approach viaducts. For this structure two different treatments were prepared to replace the original design, which was only partially executed although the bridge has been in use since 1931. For a general discussion of relations between the professions, the reader may wish to refer to Mr. Embury's article "The Architect and the Engineer," published in "Civil Engineering" for January 1938. His forthcoming article, on the esthetic design of steel structures, will appear in an early issue.

It is not as easy to use what might be called automatic design (memory or repetition instead of imagination) for the anchorages of a suspension bridge as it is for other parts of a bridge structure, because this problem does not occur very often in engineering practice. Also, since the anchorage is of masonry, the architect naturally thinks he knows more about it than does the engineer. The latter, whose principal work is nowadays in steel, is inclined to agree with him, and after he has worked out his foundations, his connections, and his loads, is willing to let the architect "dress up" the outside in almost any way he thinks appropriate. Any architect who has worked with an engineer on an anchorage problem, or any engineer who has worked with an architect, will probably agree that this is a statement of fact, not just an assumption.

In the design of the anchorages of three large bridges, I have had the good fortune to work in close association with the engineer of design, Allston Dana, M. Am. Soc. C.E., and in the course of this association, we have learned certain things which perhaps deserve to be recorded. The anchorages referred to, in the order in which we studied them, were those of the Triborough Bridge, the Whitestone Bridge, and the George Washington Bridge. In all three cases we worked under O. H. Ammann, M. Am. Soc. C.E., chief engineer (now director of engineering), of the Port of New York Authority. We had a fairly free hand, although, of course, the designs were always subject to Mr. Ammann's criticism and never out of his control. We were, in a sense, his instruments, and were guided by his desires as to the lines along which we should proceed. Of the three bridges, the first and the last had been begun when we approached the problem; the Whitestone anchorage was the only one designed *de novo*.

DESIGN OF TRIBOROUGH BRIDGE ANCHORAGES

In Fig. 1 is shown the work already completed on the anchorages for the Triborough Bridge when Mr. Ammann was made chief engineer by the new commission and we were employed to work up the design. This anchorage was originally intended to hold four cables but was redesigned for only two cables, the new attachment of the cables to the anchors requiring additional concrete in the anchorage.

In this case the architect lacked all knowledge of how

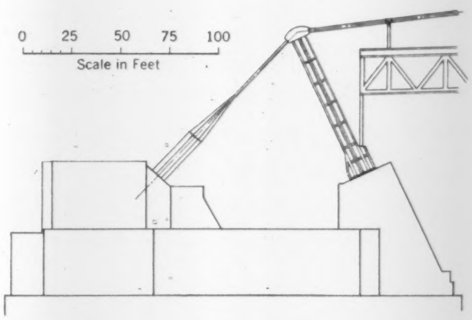


Fig. 1. Status of Triborough Bridge Anchorages When New Design Was Undertaken

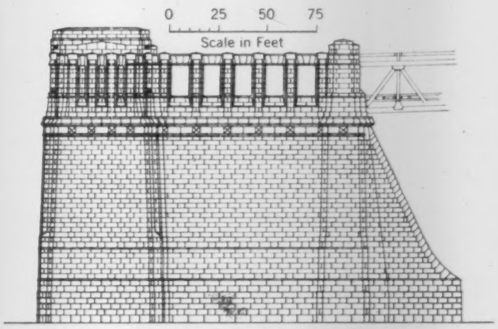


Fig. 2. Original Design Contemplated for Triborough Bridge Anchorage

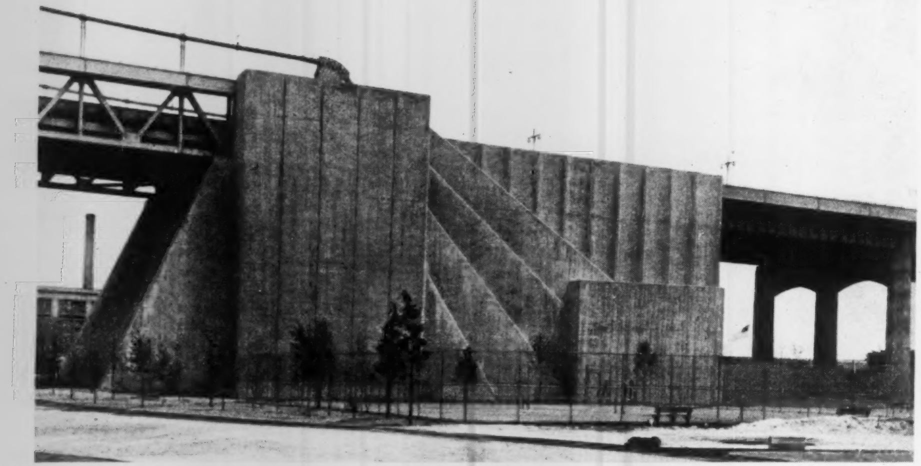


FIG. 3. PHOTOGRAPH OF COMPLETED TRIBOROUGH BRIDGE ANCHORAGE
The Diagonal Fins Suggest the Force Exerted by the Cable Upon the Anchorage

an anchorage functions and what most bridge anchorages look like, so that at least he was neither fettered by tradition nor hampered by knowledge. We were given no particular instructions as to how the chief engineer wanted the anchorage to look. The construction was to be concrete with an exterior finish or surface treatment suitable to the material. It was carefully explained to the architect by his engineer colleague that the cable of a suspension bridge, which is nearly horizontal at the anchorage, must change direction and turn downward into the earth rather quickly, and that the large steel arms which were already projecting from the anchorage were a sort of glorified clothes-pole around which the cables were to be bent downward. The front of the anchorage had to serve as a pier for the stiffening truss of the roadway, and the back as the end pier of the viaduct. As shown in Fig. 1, there was a considerable amount of existing concrete which was perhaps unnecessary in the redesigned bridge, but which certainly had some function. Each of the breaks or projections which then existed was incorporated in our final design, although in the original design (shown in Fig. 2) these breaks were to be hidden.

We paid little attention to the design shown in Fig. 2, which seemed more like an 1870 postoffice unfortunately located in the flats than an anchorage for a bridge, although anchorages of this type were quite the thing in the old days when architects conceived that their mission in life was the covering up of the ugly structures designed by engineers. We wanted our anchorage to look like an anchorage and like nothing else. We felt that in a material like concrete, large plain surfaces were almost essential and that the only proper decoration would be offsets or recesses that would cast sharp, hard shadows on the surface. We felt also that a structure of this kind must be treated without any attempt at conventional architectural ornament, particularly doors and windows, which would make it appear to be a hollow shell instead of the solid weight it actually is. At the same time, it would be desirable to indicate the play of forces within this solid mass. While in scale and size the steelwork appears almost lacelike beside so great a block, we believed it would be possible to so design the surface of this mass that it would appear to be a part of, and designed with, the steel which it supports. The completed anchorage is shown in Fig. 3.

The principal force acting in the anchorage is unquestionably exerted by the cable as it spreads out and is tied to the concrete mass, which thus acts as a counterpoise to the weight of the bridge. This we tried to indicate by a series of diagonal fins in the concrete following the lines of the spread of the cable, and stepped out from top to bottom instead of battered. The rear of the anchorage has a double function, both as a weight to hold down the cable and as a support for the ends of the first girders of the viaduct. We felt that a great single block of concrete, without breaks of any kind, not only would constitute a dull and uncompromising mass but also would show discolorations and form marks much more than if it were broken up by surface treatment of some kind. Accordingly we treated the mass at the rear with vertical flutes of great width and large radius in a perhaps mistaken endeavor to indicate that it was a solid inert mass. At the extreme rear is half of a concrete bent to support the end of the viaduct and form a transition between the latter and the anchorage mass itself

In other words, this design was made without reference to any precedent—either architectural or engineering—solely to interpret the functions of the anchorage Neither of us very much likes the word "functional" but no other word seems to quite fit this type of design. At any rate, these two great pale-colored blocks seem to us to fulfill their function as they crouch at the ends of the bridge, strongly resisting the pull of the cables.

NO LIMITATIONS ON WHITESTONE DESIGN

No limitations existed on the design of the Whitestone anchorage except that it should both hold the ends of the cables and appear to hold them. The chief engineer, Mr. Ammann, had indicated his desire that the whole bridge should be smooth, sharp, and clean; that the stiffening trusses of the floor should be plate girders; that the towers should have no portal bracing near the roadway but only at their tops; and that these portals should have the form of an arch. We prepared for submission to

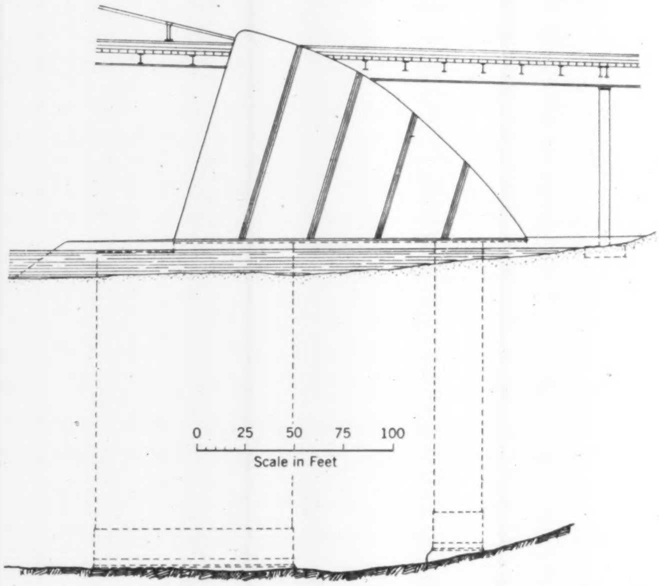
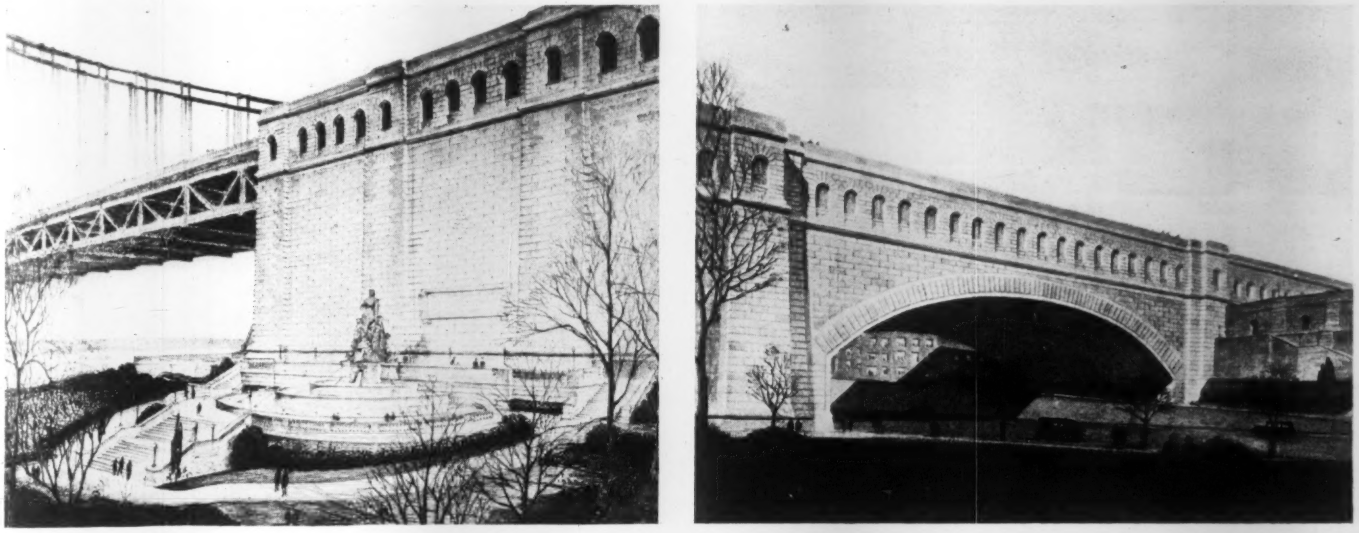


FIG. 4. DESIGN FOR ANCHORAGE OF WHITESTONE BRIDGE

Mr. Ammann several other anchorage designs based on more or less conventional ideas before we conceived the particular form that was finally adopted. The principles upon which this final design is based are, roughly, that the forward side of the anchorage shall be battered at a slope perpendicular, or nearly perpendicular, to the slope of the cables at the point where they enter the anchorage, and that the anchorage itself shall take approximately the form of the cables as they bend around the rocker arms and enter the concrete.



Bridge Anchorage, Showing Three of the Four Pilasters

Fourth Pilaster of Anchorage, and Viaduct Arch Over Drive

Fig. 5. Cass Gilbert's Design for Structures at East End of George Washington Bridge

In the past it has been customary to indicate by masses of concrete the great loads at the rear of anchorages, but in this case, since foundation conditions were so bad that the whole mass had to be supported on caissons of considerable depth, it actually proved more economical to use the weight of the whole anchorage as an anchor rather than to divide it into parts—the lever or buttress at the bend of the cable, and the anchorage proper. It is expected that a considerable downward pressure will be exerted on the toe of the anchorage—one much in excess of that at the rear or shore ends—due to the uplift of the cables, which are naturally anchored near the back; and the mass was reduced both for reasons of architectural effect and practical construction to an extremely simple shape. The finished design is shown in Fig. 4.

We believe that the very simplicity of design of this anchorage carries out the "feel" of the steel towers and stiffening girders of the bridge. Its decoration is reduced to four heavy flutes parallel with the batter of the inner face of the anchorage. Since a bridge anchorage, if seen at all, is almost inevitably seen from a considerable distance, we felt that any further breaking up of the mass was not only unnecessary but actually detrimental, and would spoil the simple and very carefully studied proportion between the battered inner face and the gentle curve of the upper surface. The ornamental lines were placed as indicated because we felt that the forces acting within the structure were like those produced in an accordion when the ends are pushed in—that the cable is actually tending to compress the structure. Furthermore, we needed some construction joints, and neither horizontal lines, vertical lines, nor those following the curve appeared to have functional significance or to give a good esthetic effect. We are conscious of the fact that this design is an experiment, perhaps a rather daring one, but we hope that its very boldness and stark simplicity will mark it as belonging to a bridge and to nothing else in the world.

REDESIGNING GEORGE WASHINGTON BRIDGE ANCHORAGES

The anchorage of the George Washington Bridge presented a problem entirely different from either of the two just described. In the first place, there is no sloping approach viaduct. On the New York side, the anchorages are so close to the high ground to the east of Riverside Drive that the only approach is a single arch across the drive; while on the New Jersey side there is no viaduct at all—the anchorage there is cut out of the solid rock of the Palisades. When the bridge was built, the design of the exterior of the anchorage was to be as shown in Fig. 5. However, because of lack of funds, completion of the anchorage was postponed until traffic conditions should necessitate construction of the lower deck of the bridge. Therefore, only enough of the rough concrete core was poured to anchor the loads applied on the single deck, plus such foundation work as was expected would be required to execute the design of the original architect (the late Cass Gilbert). The present condition of the anchorage is indicated in Fig. 6.

During the time the bridge has been in use it has become apparent that because of the excellent plan, the single deck will carry far more traffic than was originally believed possible; hence construction of the lower deck has been postponed indefinitely. However, the existing anchorage is far from ornamental, partly because it was not planned with the idea that it would be exposed, and partly because it is surrounded by light steel construction designed to support the roadway pending completion of the anchorage. With construction of the new West Side Improvement, the Port of New York Authority has felt it a duty to improve the appearance of the anchorage, and we were requested to prepare a design, under the direction of Mr. Ammann, for this purpose. These studies have resulted in two alternate designs, neither of which at this writing has been adopted as final. Both are discussed here because they illustrate two different and equally logical avenues of esthetic approach.

Were this anchorage a free-standing structure entirely separated from the tremendous retaining walls which exist at the east of Riverside Drive at this point, we believe there would be only one solution—that is, the anchorage should be designed with an eye solely to its relation to the magnificent steel structure of which it forms an integral part. However, the anchorage is only about 150 ft distant at its land end from a masonry structure even larger than itself, to which it is connected by a masonry arch bridge, so that the whole anchorage can be regarded as an artificial promontory jutting out to the west from Riverside Drive to meet the steel structure. This was the point of view taken by Cass Gilbert. He regarded the anchorage as a great square block extending out from the retaining wall and having little or no relation in scale or character to the steelwork of the bridge. As a matter of fact, this is precisely the situation on the Jersey side, where the cables are anchored into the cliffs, which being purely natural formations, have no relation whatever to the artificial bridge structure entering them.

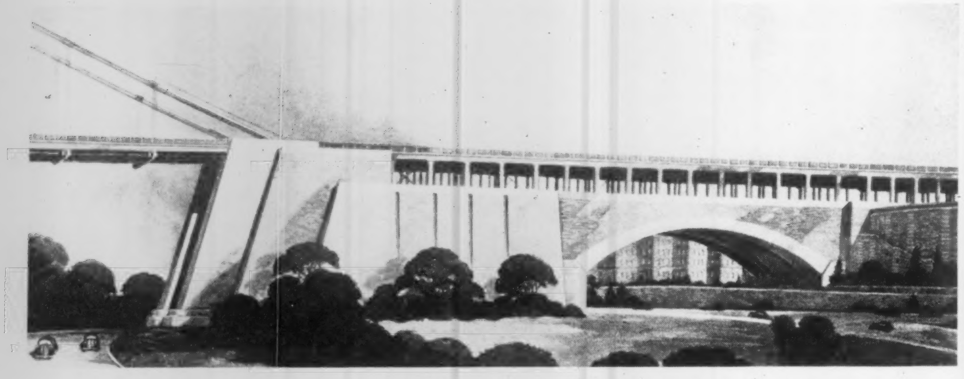


FIG. 7. DESIGN FOR EAST ANCHORAGE OF GEORGE WASHINGTON BRIDGE
This Design by O. H. Ammann, M. Am. Soc. C.E., Has Now Been Adopted

The other avenue of approach is that the anchorage is not an inert mass which happens to be able to do what is required of it, but is rather a live, articulate structure in which the forces are constantly acting with varying strengths as the loads from both traffic and wind change on the bridge itself. However, its location so near the retaining wall of Riverside Drive makes essential some homogeneity between the shore structure and the anchorage, as Mr. Ammann himself has forcibly pointed out.

WHY ORIGINAL DESIGN WAS NOT FOLLOWED

This is perhaps a good place to discuss why Cass Gilbert's original design was not retained without material alteration. The considerations which induced us to suggest alternate schemes also apply to all anchorages of any magnitude. It will be noticed that the original design, Fig. 5, is of traditional type; although adapted as far as possible to a new condition, it is an anachronism in a modern steel bridge.

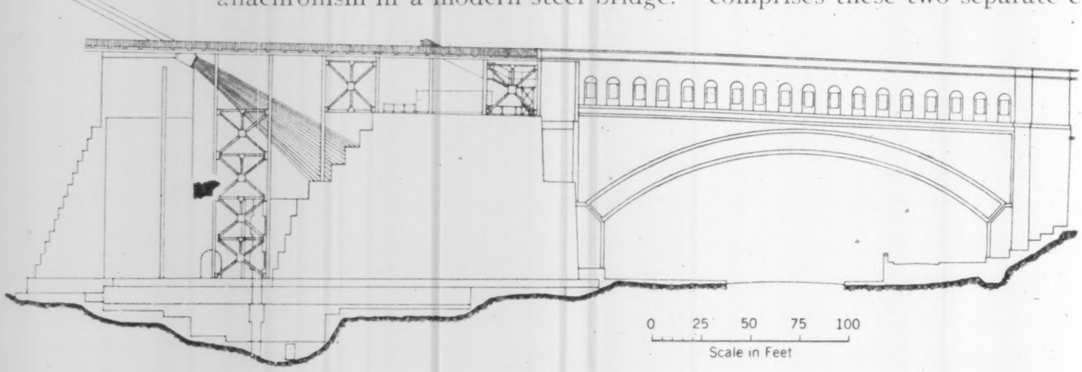


FIG. 6. PRESENT CONDITION OF EAST ANCHORAGE, GEORGE WASHINGTON BRIDGE

In the first place, the vast bulk of the structure indicates the need for smooth, unbroken surfaces. Any ashlar surface composed of relatively very small units, suggests building construction rather than a solid mass. On the other hand, any increase in the size of the building stones over those ordinarily used tends to decrease the apparent size of the anchorage as a whole. Furthermore, the arcade, which is actually an ornamental treatment along the top of the anchorage, intended to extend to the lower deck when built, suggests a hollow building. Finally, decoration with quoins and cornices, even reduced to a minimum as it is in this case, is so obviously derived from hollow structures and so dissociated from steelwork in all our minds that it cannot possibly be reconciled in scale or in character with the other parts of the bridge.

A similar question arises regarding the design of the Philadelphia–Camden Bridge, where Paul P. Cret, one of the most distinguished and progressive architects in America, approached the anchorage design from the same direction as Mr. Gilbert. He used great blocks of rough ashlar for the facing, endeavoring by their size and roughness to give a feeling of strength; built two towers at the rear of the anchorage to indicate the point of greatest load; and decorated the whole with moldings and openings, not very classic it is true, but derived from classic sources. The result is, in my opinion, that the structure, no matter how one may feel about it as a separate entity, is a failure in that it appears trivial compared with the terrific scale of the towers and steelwork, and gives the impression of being hollow rather than a solid block. It might be a magnificent warehouse or a superb old fortress but it certainly is not an anchorage.

In the new designs, Figs. 7 and 8, we have endeavored to bear all these points in mind. The design illustrated in Fig. 7 is distinctly based on the "promontory" conception of the anchorage. It is an extention of the retaining walls across Riverside Drive to the solid block of the anchorage. For the main part of the structure we used the same fairly rough stonework in small units that is used on the retaining walls, believing that we can thus produce a continuous surface and not a broken one, which would be the result of using ashlar. For the masonry arcade we have substituted a steel viaduct, indicating as plainly as we can the difference in function between the upper part of the structure, a viaduct, and the lower part, a solid inert mass. This particular anchorage actually comprises these two separate elements, as will be noted in Fig. 6, which shows its present condition. The forward or lever part is really a buttress around which the cable is bent, and the rear part is the weight—the block of masonry which holds the terrific loads of the span. While in the design illustrated by Fig. 7 it is impossible to completely express the functions of the two parts of the structure, an attempt has at least been made to show that something is going on inside by the treatment of the side elevation in three battered planes broken inward towards the cables, the section towards the river encasing the buttress only. Because the function of this riverward section is actually different from that of the rest of the anchorage, we have chosen an encasing material of smooth granite with very small joints in very large panels, so as to form an intermediate link between the hard, smooth outlines of the steel and the softer and rougher masonry work of the anchorage proper and the Riverside Drive retaining wall.

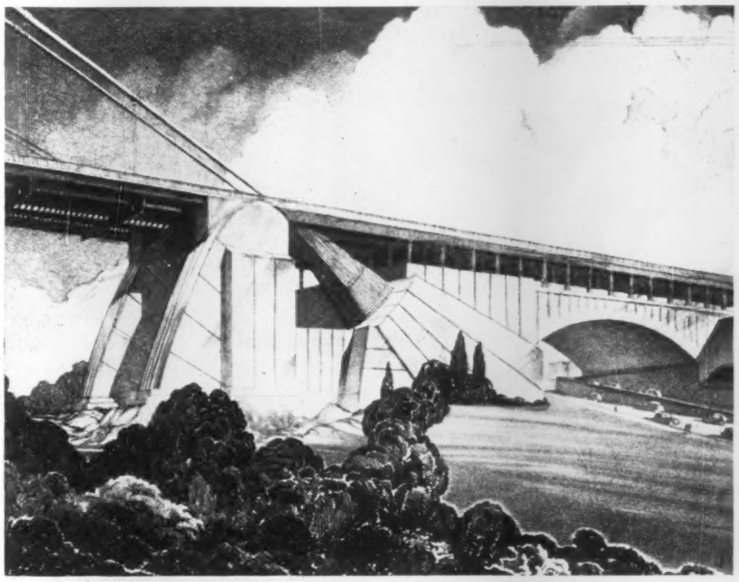


Fig. 8. Alternate Design for East Anchorage of George Washington Bridge
As Proposed by the Author

The alternative design shown in Fig. 8 is based primarily on our conception of what an anchorage does. We all like to know how things work, whether they are locomotives or radios or bridges. If we can show by forms that are beautiful in themselves how a thing works, and then in some way tie them into their surroundings, we feel that we have accomplished our heart's desire. In this design, the encasement at no point diverges very far from the actual structure now in place. Instead of the stepped river end of the buttress, we have used a curved form suggestive of the spiral, which (it happens) parallels rather closely the line of force acting through the buttress. The spread of the cable is exposed and the encasement of the eye-bars in concrete is indicated by incised lines in the concrete radiating from a center at the point where the strands begin to divide. By horizontal pour-lines recessed in the concrete, we have endeavored to indicate that the masonry above the eye-bars is placed there for weight alone. We have regarded the arch over Riverside Drive as a link between the anchorage and the retaining wall, and have treated the viaduct in substantially the same way as in the other design except that the large span over the cables has been carried on a plate girder.

This design, like the other, has been studied with great care to bring out its strength and disguise its weaknesses, but we have not been able to tie the anchorage into the Riverside Drive arch in the easy, fluent way we would like to do. As seen from the Drive itself, our perspective studies show that treatment of the buttress as a separate entity tends somewhat to confuse its function. The question as to which of these two anchorages is the better seems to us to depend on two things: First, which will be the more interesting structure as seen from the new West Side Driveway and existing Riverside Drive; and, second, which is the better intermediate link between the masonry along the Drive and the bridge itself. [Since this writing the first design has been adopted.]

SOME PRINCIPLES APPLICABLE TO ALL BRIDGES

While this discussion has been concerned primarily with the three bridges on which we have worked, we have touched on certain points applicable to all bridges. No forms derived from ordinary masonry building construction are applicable to structures in close proximity to steelwork of great size, which means that anchorages, piers, foundations, and abutments for steel structures must not be reminiscent of classic architecture, but must be designed, as it were, out of whole cloth. This constitutes a fairly difficult problem; it is always easier to remember than to invent, and further, there is not the guide of intelligent public opinion formed through years of familiarity with similar structures. We believe that in general any form which does what it is supposed to do without waste and without ornament will, if not positively good, be reasonably successful.

There are, however, certain artistic instincts in human beings which lead them to special forms. The circle and the square are examples of natural forms which almost everyone likes. The same is true to a lesser extent of all the curves of a simple equation. For example, most people will prefer an ellipse to the compound curve of a three-centered arch, and as among several three-centered arches will prefer that which approximates the ellipse most closely. A true spiral almost always gives a pleasing impression.

When we come to other than very simple forms, however, there will inevitably be differences of opinion. To take an elementary example, no two people will like the same relation between the height and breadth of doors. And so, when we come to complex arrangements of planes (simple though they may appear after they have been designed) as we have used them on these anchorages, we feel that we are rather groping towards a conclusion than that we have definitely arrived at one.

Take, for example, the anchorage of the Whitestone Bridge. The batter of the front face was studied over and over again in its relation to the curve of the rear, and we now have a shape that pleases us both, we do not know why. Having arrived at this simple form, we tried treatments of the surface in every manner that we could imagine, by horizontal lines, by curved lines, by vertical lines, and finally adopted slightly sloped lines. Again, we do not know why. In the second design for the anchorage of the George Washington Bridge, we had fairly definite elements to guide us. The anchorage actually shows what it does without any padding of concrete here or cutting of it there, but we felt also that very slight changes in the curve of the front of the concrete rocker, in the width of the splay enclosing the eye-bar anchors, or in the relation of the incised lines by which the surface has been decorated, materially changed the effect of the structure. Naturally we picked that combination which we thought was the best.

It may be of interest to mention that, in our collaboration on these designs, as a rule it has been the architect who has suggested and the engineer who has acted as the artistic critic—a reversal of function that has somewhat surprised us.

From Farmer Boy to College Dean

Personal Reminiscences of Training Through Country School, Annapolis, and Naval Service

By Mortimer E. Cooley
Honorary Member American Society of Civil Engineers
Dean Emeritus, Colleges of Engineering and Architecture, University of Michigan, Ann Arbor, Mich.

This very human document was never intended for its present use. It was supplied by Dean Cooley in answer to a request for what was expected to be a rather formal biographical statement. But its delightful personal touch, its frank appraisal of an interesting boyhood and early engineering education, immediately marked it as worthy of a special place in professional annals. It records the transformation of a naive farm lad into a dashing young naval officer and cosmopolite, and his final development into the dean of one of the foremost and largest American technical schools. The many who know Dr. Cooley intimately will immediately recognize in this story some of the elements of his experience that have combined to produce his strong, virile personality; while those who do not know him will better understand his popularity and his reputation as a raconteur par excellence.

To review one's early experiences in a sort of detached spirit and from the vantage point of octogenarianism is not as simple as one would imagine. What after all were the controlling forces and critical decisions? Certainly they were not always the events that assumed exaggerated importance at the moment; rather they were frequently those accidental happenings, small in themselves, but all out of proportion to their intrinsic size, in the results that they accomplished. So I think that, rather than to tell of professional doings, it may be of more interest to others as it is to me, to consider some of those influences, mostly of a personal nature, that have directed and impelled me through life.

I was born (in 1855) on a farm half way between Canandaigua and East Bloomfield in New York State. My earliest recollection is of a bright-colored Scotch plaid jacket and shiny patent-leather belt, when dressed for Sunday School at four or five years of age. Did I strut? My brothers and sisters said I did.

My next vivid recollection is when my oldest brother went to war in 1862. I was then seven years old. He came home, dressed in his uniform, to say good-bye. I donned his cap and went off to school with it to strut some more. Then came the war pictures in *Harper's Weekly*, the wounding of my brother at the Battle of the Wilderness, and his return home on furlough. Meantime, I attended district school, built fighting rafts, fought battles with my companions on old Schoolhouse Creek, and grew up. In 1933 my recollection of those days was still so vivid that I wrote the accompanying verses—"Schoolhouse Creek, 1860–1870."

COUNTRY BOY'S EDUCATION

To grow up on a farm and go to a district school was a liberal education. I am thankful to have started that way. In the country, families and neighborhoods depended on themselves; they created their own entertainment. Children made their own toys—there was no money to buy them. At fourteen I had saved $1.63, mostly pennies. Father gave each of us half a dollar to attend the county fair, and an occasional circus—no, menageries they were in those days. *Uncle Tom's Cabin* was my only real "show" while at home.

One lesson I shall never forget—literally it was beaten into me. Half a dozen of us boys ran away from school to go swimming one irresistible day in May. We tried every old swimming hole for a couple of miles along the creek in which farmers washed their sheep before shearing in the spring. Arriving home too late for the evening chores, and fearing detection, my brother Ernest rolled himself in the trash on the woodshed floor to conceal his wet clothes (he had fallen into the creek). Older brothers and sisters said, on the side, "You'll catch it!" But nothing happened, and we ate supper and went to bed fairly well content with our adventure.

Next morning, while I was sitting on a timber being framed by a carpenter, my father came through the orchard gate with a freshly cut pole some eight or ten feet long, which I thought he intended for an ox-goad. But no! Coming along side he said, "Stand up, young man!" I stood up. He then flogged me until only two or three feet of the butt remained. Stopping, he said, "Young man, will you run away from school again?" I replied, "I think not, Sir." With that he flogged with the butt until tired, stopped again, and said, "Young man, I don't want any thinking about it. I want to know!" I then said, "No, Sir." He threw down the stick and explained: "The only thing I ever expect to leave you boys is an education; and by —, you'll get that!" adding as an afterthought, with what I think now was a twinkle of the eye: "— if the apple orchard holds out!" What more could a boy in his early teens have to start him off down the middle of the road?

Almost Ready for Naval and Other Conquests
Cadet Engineer Cooley, Age 23, at the U. S. Naval Academy, Annapolis

A CALAMITY AND ITS EFFECTS

One of my early boyhood memories is the burning of our farm buildings at the end of the harvest in 1865—the greatest harvest we had ever had. It was expected to pay off the mortgage and make us one of the well-to-do families in the neighborhood. That fire changed the entire life of our family. At one time, father seriously considered moving out to Iowa. But neighbors came to our rescue, built a new barn, and helped us start again. At that time, farms in Ontario County were valuable. We were offered $150 an acre for 190 acres. A few years ago the old farm was offered at $35 an acre. We hung on through the depression of 1873, but could not survive the depression of the early eighties.

Yes, the fire was a turning point in the lives of the eight children of our family. I was hired out by my father to teach district school during the winter of 1872–1873, being then seventeen. I taught again in the winter of 1873–1874.

Probably nothing influenced my life more than the old *New York Ledger*. It was a family story paper, a forerunner of the modern novel. One story in particular is responsible for much that happened to me—the story of Beckett Burton by Sylvanius Cobb, Jr. Beckett went to sea as a cabin boy and became master, at twenty-one, of one of the first Clipper Ships out of Boston. Returning from the Indies he put in at Cape of Good Hope and learned that the United States was at war with Great Britain (1812). He discharged a part of his cargo, took aboard some guns, enlarged his crew, and sailed into Boston Harbor as a privateer with several prizes. When asked how he dared do such a thing without knowing the right or wrong of the cause, he replied, "I fight for my mother first and find out whether she is right or wrong afterwards."

Schoolhouse Creek, 1860–1870

Would I could hear again the murm'ring brook
That winds through sunlit field and shady nook;
And runs beneath the bridge above the pool
We crossed when on our way to district school;—
The old red brick in District Number One,
Which stood well back and faced the morning sun.

A hick'ry tree before the schoolhouse door,
An elm close by the road, and many more
The other side where ferns and swale-grass grew;
Where gentians fringed the bank, and meadow rue,
Triumphant, waved its plumes above the rest.
And this the shady nook the creek loved best.

Down through the tall rank grass and goldenrod
The channel undermines the peat-like sod;
And grasses intertwine above the gap—
A nymphal grotto where the naiads nap.
It opens here and there, but in between,
The chuckling, laughing brook runs on unseen.

Yes, here and there the creek spreads out in pools,
Where birds are wont to bathe; where minnow schools
Chase round and round—play tag; where polliwogs
Unship their tails and change to full-grown frogs;
Where, when his frogship jumps in with a splash,
A crimson streak reveals the redfin's dash.

A weeping willow stands near by the creek.
It droops and weeps. Ah, me! could it but speak,
What tales it would relate;—of boys and girls
In search of fairy realms. But look! What hurls
Itself—that flash of gray across the swale?
A bird has cleft the pool!—The Willow's Tale.

The willow bows its head while bluebells toll.
The murm'ring brook recites the minnow's roll.
Then steals away beneath its grassy sky,
Where muffled ripples croon a lullaby.

ENTERING ANNAPOLIS IN THE OLD DAYS

And so I went to the U. S. Naval Academy as a cadet engineer in 1874. Only 25 were admitted annually, on competitive examination. I did not know a congressman or a senator, so I simply wrote the secretary for an appointment. Not hearing from him promptly, I wrote again. My letter must have amused him. He answered excusing (?) himself for not replying earlier, saying he had been abroad, and enclosed the necessary papers. In due course I reported for examination at Annapolis, where I found 75 or 80 others awaiting the competition. Needless to say my heart sank. Some of the subjects were new to me. But I sat through the whole time for the five or six days, then took the train home. Although I felt I had done my best, I hired out to teach in the Canandaigua Academy.

Imagine my surprise two or three weeks later on receiving orders to report at once. I did not then know that "at once" gave me twenty-four hours to start. The telegram came at noon. I walked $3^1/_2$ miles home, packed my bag, and caught the 4:00 o'clock train that landed me in Annapolis next morning. In Baltimore I met Ira N. Hollis from Louisville, also on his way to Annapolis. We were roommates for four years and sailed our first cruise together after graduation in 1878. Later Hollis became professor of engineering at Union College, then at Harvard, and finally retired as president of Worcester Polytechnic Institute.

Hollis was keen to know his standing in the competitive examination. I was satisfied enough just to be "in." But I went with him and joined in his pleasure at finding himself No. 1. Disclaiming any curiosity about my own standing, I was informed that I had passed No. 7. I captained my class four-oared boat crew for two years and dropped to No. 14. Then the boat house was wrecked in a violent storm and blown out into Chesapeake Bay. After that I gave all my time to study and was graduated No. 7. Outside of boating, there was little in the way of athletics. Fencing, boxing, and pistol target practice were required exercises.

SOME PRACTICAL ENGINEERING

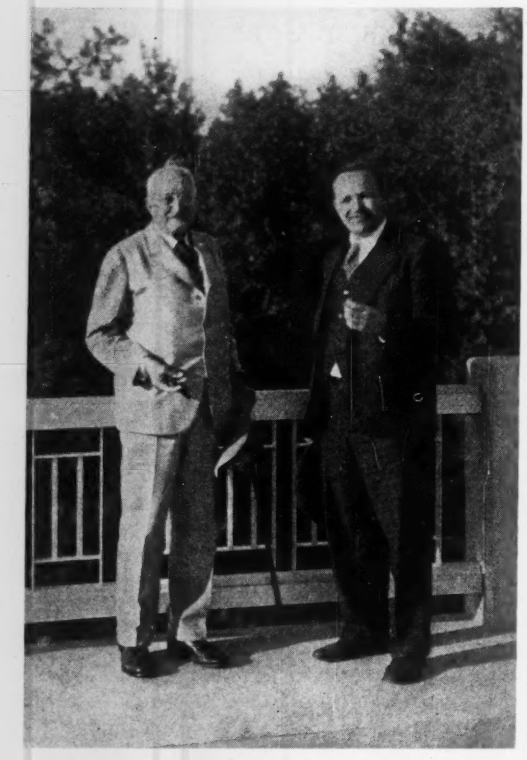
Following graduation Hollis and I were ordered to the *U. S. S. Quinnebaug*, fitting out at Norfolk Navy Yard for the European Station. Congress would authorize no new ships but it would appropriate money to repair old ships. Some marvelous transformations came about as a consequence. It was said only the bell remained of our ship. When repaired, it became one of our best fighting crafts. Whether or not the *Quinnebaug* would be allowed to go to the European Station was conditioned on her making 14 knots on her trial trip. Originally she was fitted with the old-time box boilers carrying 12 to 15 lb steam pressure, and a pair of 60-in. cylinders—engines horizontal so as to be below the water line. In repairing, a 42-in. cylinder was put inside one of the 60-in. cylinders; and cylindrical boilers 8 ft long and 8 ft in diameter (known as powder-kegs) replaced the old box boilers. The steam pressure was 80 lb. Thus came about the first compound engines in the Navy.

Being junior officers, Hollis and I stood watch in the fireroom. Our job was to keep the safety valve singing.

The ship made better than 14 knots and we went to Europe. What a revelation was that trip across the Atlantic, with low-pressure copper piping bursting, boilers foaming, feed-pumps out of whack, crankpins heating—everything happening that could happen with a pressure of 80 lb on machinery designed for from 12 to 15 lb. But our chief engineer, John S. Albert, was equal to every emergency. He was the same John S. Albert who was in charge of machinery at the Centennial Exposition in Philadelphia in 1876. I probably learned more practical steam engineering on that one cruise than in all my life since.

Our first port was Gibraltar where we filled our bunkers with Welsh coal. Smokeless anthracite was used in the

American Navy; it required a thin fuel bed, spread uniformly over the grates, and no stirring with a slice-bar. Welsh coal required a thick fuel bed and plenty of slicing. Grate-bars last indefinitely with anthracite, but warp and burn out continuously with softer coals. We lost so many grate bars that a new supply was acquired at Alexandria, Egypt. When brought aboard, one accidentally dropped on the deck and broke in pieces. The lot was immediately condemned and about to be removed when John S. Albert appeared to countermand the order. He explained that he had particularly specified the use of a cold-short iron. The trouble with American-made bars was the fine quality of machinery cast-iron used. They would not stand the heat, while a poorer iron would.



AT THE DEDICATION OF COOLEY BRIDGE OVER MANISTEE RIVER, MICHIGAN, SEPTEMBER 1935, NAMED IN HIS HONOR

On the Right Is Murray D. Van Wagoner, State Highway Commissioner

ALSO A TASTE OF DIPLOMACY

From Gibraltar, we sailed for Villefranche where we met and exchanged courtesies with ships of other nations, incidentally attending the famous Mardi Gras of Nice; and Monte Carlo—after pay-days. Then came the Mediterranean cruise—Port Mahon, Malaga, Gibraltar, Tangiers, Algiers, Tunis, Alexandria, Joppa, Smyrna, Constantinople, Athens, Trieste, Venice, Naples, and back again to Villefranche.

The visit to Tangiers was by request of our State Department. So many years had passed since the American flag had been seen in that port, Tangerians thought of the United States as a minor part of the world. Our consul there was treated accordingly. On arrival, an audience was arranged with the Dey; and our Captain with all the officers not on duty, rigged in full-dress with cocked hats and side-arms, paid their respects. Our reception was delightful. The Dey invited the ship's company to go on a boar hunt, the great sport of that country. Unfortunately, our stay was too short. After we left, our consul reported to the State Department that he had become one of the Dey's chief advisers.

ANCIENT ENGINEERING FASCINATES

At Tunis I visited the site of ancient Carthage and was tremendously impressed by the ruins of the old aqueduct and the still perfect condition of the concrete used in its construction. The same is to be said of the concrete water pipes found by the side of the road between Jerusalem and Bethlehem, which at one time supplied the pools near Jerusalem. From Joppa to Jerusalem in 1879 was a horseback ride of 10 or 12 hours. The land was tilled by wooden plows as of old. Remains of American plows were seen by the roadside.

For the engineer, probably the most interesting spot in Jerusalem is the underground quarries, entered from outside the walls just east of the Damascus Gate. The banks of stone chips 25 or 30 ft high in a great artificial cavern explained why the temple was built without the sound of a hammer being heard.

The obelisks in the squares at Alexandria, since removed to London and New York, naturally raised the engineering question of how they were transported and put in place—a much greater question in 1879 than now. Piraeus, the port of Athens, and Athens itself, with its temples of an unrivaled age, all left their imprint on the susceptible mind of a 24-year-old son of a mother gifted with imagination and a deep student of Josephus.

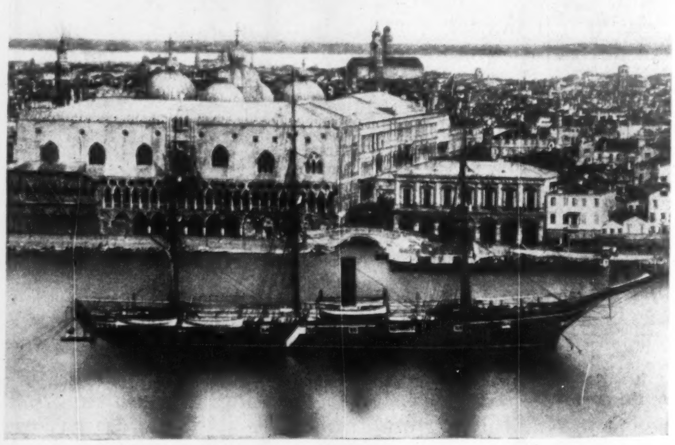
The canals and bridges in Venice; the ruins of Pompeii and Herculaneum near Naples; Lake Avernus with no outlet, which Agrippa converted into a naval harbor by building canals and a tunnel half a mile long (the Grotto Pace)—all are objects of interest to the engineer.

That being so, why have not more members of the profession interested themselves in the engineering of the older civilizations? Is there an engineer attached to any of the archeological expeditions now at work uncovering examples of such excellence that we ourselves would be glad to father them?

ALMOST AN INTERNATIONAL DIFFICULTY

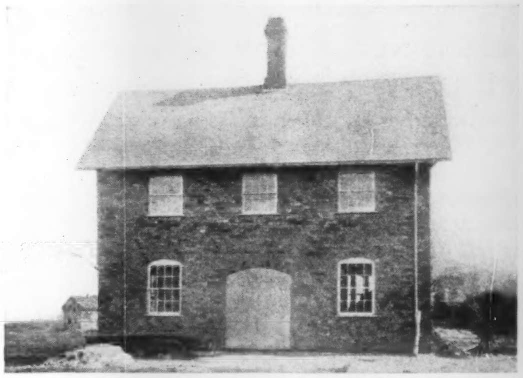
Our visit to Constantinople came near being a diplomatic incident. We were anchored in the Bosporus opposite the sultan's summer palace. A great ironclad the Turks had recently purchased from England was hard by. Two shipmates had gone up to the Black Sea, and leaving their steamer above the palace, had taken a caique to come aboard.

Passing the summer palace (harem), Hollis (so he told the story) took out his handkerchief to wipe his hands after trailing them in the water. The palace guard thought differently, ordered the caique ashore, arrested the two officers, and cast them into the dungeons under the palace. Later they were taken before a magistrate. As no one understood English, explanations were unsatisfactory and the outlook became gloomy. Fortunately a German drifted in, through whom the matter was explained.



U.S.S. Quinnebaug AT VENICE IN 1879, WITH DOGE'S PALACE AND PRISON IN BACKGROUND

On their return to the ship, two highly indignant officers shifted into uniform and reported to the captain. He rose to his rank, wrote the American minister and said: "Had I known that two of my officers were imprisoned in the sultan's summer palace, I would have hoisted anchor, steamed before the palace and blown it off the land, had they not been released." And this notwithstanding the nearby dreadnaught which the Turks had recently acquired from England! Mr. Maynard, our minister, evidently made the matter clear to the Porte, for next day the admiral of the Turkish Navy came aboard in state, met the young gentlemen with the captain in his cabin, apologized, and offered the United States Government some old cannons as a peace offering.


First Engineering Building, Built in 1881–1882 at a Cost of $2,500

East and West Engineering Buildings as They Are Today

THE NEW AND THE OLD AT THE UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH.

DRIFTING INTO TEACHING

And so the year passed to the autumn of 1879 when I was detached and ordered to the *U. S. S. Alliance*, homeward bound after a long cruise. Arrived at Norfolk the ship was thoroughly overhauled. This afforded new opportunities to acquaint myself with construction work. Later the *Alliance* made a cruise in the Northern Atlantic, and on her way south, in the autumn of 1880, I was again detached and ordered to the Bureau of Steam Engineering at the Navy Department with an opportunity to engage in design of machinery. While there I took my examinations and was promoted to assistant engineer, two years after graduation. The examination lasted a week and was both oral and written. It started with arithmetic and went through calculus; started with spelling and ended in theme writing; embraced physics in all its branches; included French and Spanish; and wound up with questions of practical experience which, except for the training under old seagoing engineers, I never could have answered.

In August 1881, I was ordered to the University of Michigan "as professor of steam engineering and iron shipbuilding," that being the language of the law passed in 1879 authorizing such details. Thus was added to civil engineering, established in 1853, a course in mechanical engineering. The time was ripe. The 65 engineering students in 1881 increased steadily until the year following the World War when, including architecture, there were 2,500.

Electrical engineering came in the late eighties. Year after year, courses had been offered in marine engineering and naval architecture until soon after 1900, when a separate degree was authorized. Soon chemical engineering came along, and a gradual splitting up of courses into specialties has taken place. All this, however, is a matter of record. This sketch deals with matters not of record, but with matters that have had a great effect on my career in engineering.

MORE NAVAL SERVICE

But let me add another word about the Navy. My original detail in 1881 was for three years. At the request of the Regents of the University of Michigan, it was extended to four years. They then invited me to resign and accept the Chair of Mechanical Engineering permanently. I did so, my resignation becoming effective December 31, 1885. But I still clung to my first love and became chief engineer of the Michigan State Naval Brigade, in which office I served sixteen years.

In the Spanish American War (1898) I served as chief engineer, first, on the *U. S. S. Yosemite*, later at the League Island Navy Yard in charge of construction. I returned to the university in February 1899.

Next came the World War. At its beginning in 1914, I offered myself for active service on a transport—not in an office. When the country finally entered, I was declared too old for service at sea. I then joined the Army and became Educational Director for the 7th District of the Student's Army Training Corps, my headquarters being in Chicago. The 7th District embraced 63 universities and colleges in Illinois, Wisconsin, and Michigan.

Imagine my satisfaction at being in a position to dictate policies to old university presidents, including my own. A story will illustrate. Arriving home for a week-end my president called me by telephone and ordered me to come to his office immediately. On my arrival, he ordered me to make some half-dozen innovations in the engineering curriculum. I said to him, "Mr. President, I take it that you are addressing me as dean of the college of engineering." He replied, "Yes, sir, I am." I then said to him: "Mr. President, as Educational Director of the 7th District, I wish to say to you, the president of the University of Michigan, that the things you want the dean of the college of engineering to do can't be done, sir! Good morning." With that I turned on my heel, but had not reached the door when he grabbed me by the shoulders and burst into great laughter. He had been trying to "spoof" me. Ever after, when we were attending alumni banquets together he would insist on my telling the story.

I must stop somewhere, and this is as good a place as any. Purposely, I have not touched on my favorite theme, education for the engineer, as it would likely lead far afield. Suffice to say that my efforts for three decades have been devoted to extending the engineering course to five and six years or more; to include in it few if any more technical subjects than at present, but to devote the added time to the study of so-called cultural subjects to the end that the engineer can take his rightful place in the civilization which he, more than anyone else, has helped to create. Ultimately, I believe our leading engineering schools will require an A.B. degree for entrance. I pray the time may not be far distant.

Utility Planning for Greendale, Wis.

A Demonstrational Suburban Housing Project of the Resettlement Administration

By WALTER E. KROENING, ASSOC. M. AM. SOC. C.E.
and FRANK L. DIETER, ASSOC. M. AM. SOC. C.E.
RESPECTIVELY ASSISTANT PRINCIPAL IN CHARGE OF ENGINEERING DESIGNS, AND (FORMERLY) CIVIL ENGINEER, FOR THE GREENDALE, WISCONSIN, PROJECT, U. S. DEPARTMENT OF AGRICULTURE

IN designing municipal water-supply and sewerage systems, many an engineer has felt his task unnecessarily hampered by unfortunate physical conditions directly attributable to unplanned growth of the community. Few have had the opportunity afforded the engineers of the Resettlement Administration of transforming pasture lands into a modern suburban village with complete facilities, including not only roads, houses, and community buildings but also a publicly owned and operated water works, sewage-disposal and garbage-incinerator plant, and electrical distribution system. In the accompanying article Messrs. Kroening and Dieter describe the demonstrational project at Greendale, Wis., where the village plan has been closely coordinated with the design of utilities to serve an ultimate population of 5,000 persons.

A MODERN model suburban village—a suburb of Milwaukee—has been planned and is now being constructed by the Resettlement Administration (now the Farm Security Administration). This project, which will initially provide housing facilities for 572 families of modest income, will include all community requirements, such as an administration building, a school, a fire and police station, a commercial center, and a recreation field and park system, as well as complete village utility facilities. The community of Greendale will be incorporated as a village, and will own and operate its water works, sewerage works, and electrical-distribution system. All the residential and utility construction work, including equipment installations, is being done by force account, using relief labor. The average daily field force is about 2,000 men. A temporary three-mile spur-track extension of an electric railway was built to facilitate transportation of men and materials to the site.

The work was greatly facilitated and integrated by having under one roof experts in the numerous related planning functions involved in the design of a complete modern suburban community. Close coordination between town planners and engineers evolved a plan that produced economical routing of storm and sanitary sewers and water mains, as well as terrain-hugging streets and roads of easy gradients, with a minimum of cut and fill. All horizontal control for preliminary and construction surveys and plans was based on a permanently marked coordinate system. A plan of the town is shown in Fig. 1.

Studies were first made of the feasibility and advisability of supplying water and sewerage facilities through extensions of mains serving the Milwaukee area. Use of the Milwaukee source of water supply was estimated to cost $314,000 as against $153,000 for an independent deep-well supply and service through the extension of the Metropolitan main sewer involved an estimated expenditure of $585,000 as against $65,000 for an independent sewage-treatment plant. Independent water and sewerage works were therefore decided upon, with provision for expansion when required. The utilities are designed for an ultimate population of 5,000 persons.

DESIGN OF THE WATER-WORKS SYSTEM

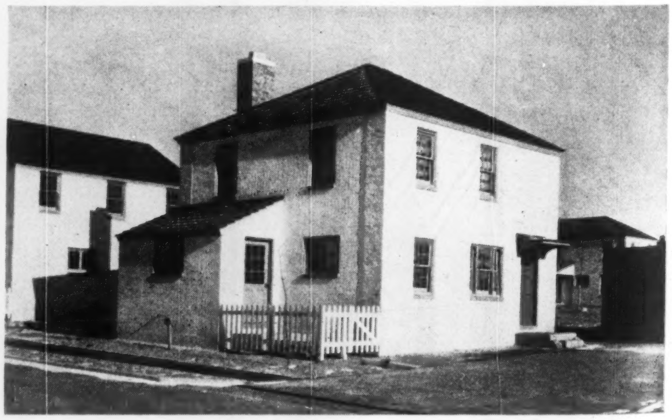
The water-works system consists of two deep wells, each with its pumping station; a water-softening plant; an elevated steel storage tank; and a complete distribution and fire-protection system. All units are designed to serve a population of 5,000 persons, allowing an average daily consumption of 75 gal per capita. The estimated maximum rates of total pumpage are 46,800 gal hourly, 750,000 gal daily, 4,585,000 gal weekly, and 14,100,000 gal monthly. The estimated average daily total pumpage is 375,000 gal.

Two wells, each having a nominal diameter of 12 in. were drilled approximately 1,800 ft deep, penetrating the Mt. Simon sandstone, a prolific water producer in this area. Together the wells produce about 1,900 gal per min, which is more than sufficient to meet the maximum hourly demand for fire and domestic use. The two pumping stations will be cross-connected, with provisions for pumping directly into the mains from either station.

The raw water has a pH of 7.m and a total hardness of 471 pp4, (28.3 grains), of which calcium is 365 ppm and magnesium is 106 ppm. The total dissolved solids amount to 614 ppm, and the iron content is 1.0 ppm.

A study of the relative costs of producing a soft-water supply by a municipal plant, by the use of individual household softeners, by rainwater cisterns, or by the excessive use of soap, proved definitely that the first means was the cheapest and most satisfactory. It is conservatively estimated that the plant (Fig. 2) will save families about $4,000 annually in soap costs alone.

Treatment will consist of aeration, sedimentation, and softening. The coke-tray type of aerator will be used to remove the hydrogen-sulfide gas in the water and provide for oxidation of the iron present. A settling tank, providing a detention period of one hour, receives the aer-



A TYPICAL SINGLE-FAMILY HOUSE IN GREENDALE

The House Contains Three Bedrooms, Living Room, Dining Alcove, Kitchen, and Utility Room (Replacing the Basement). All Houses Are Built of Cinder Block, with Clay Tile Roofs

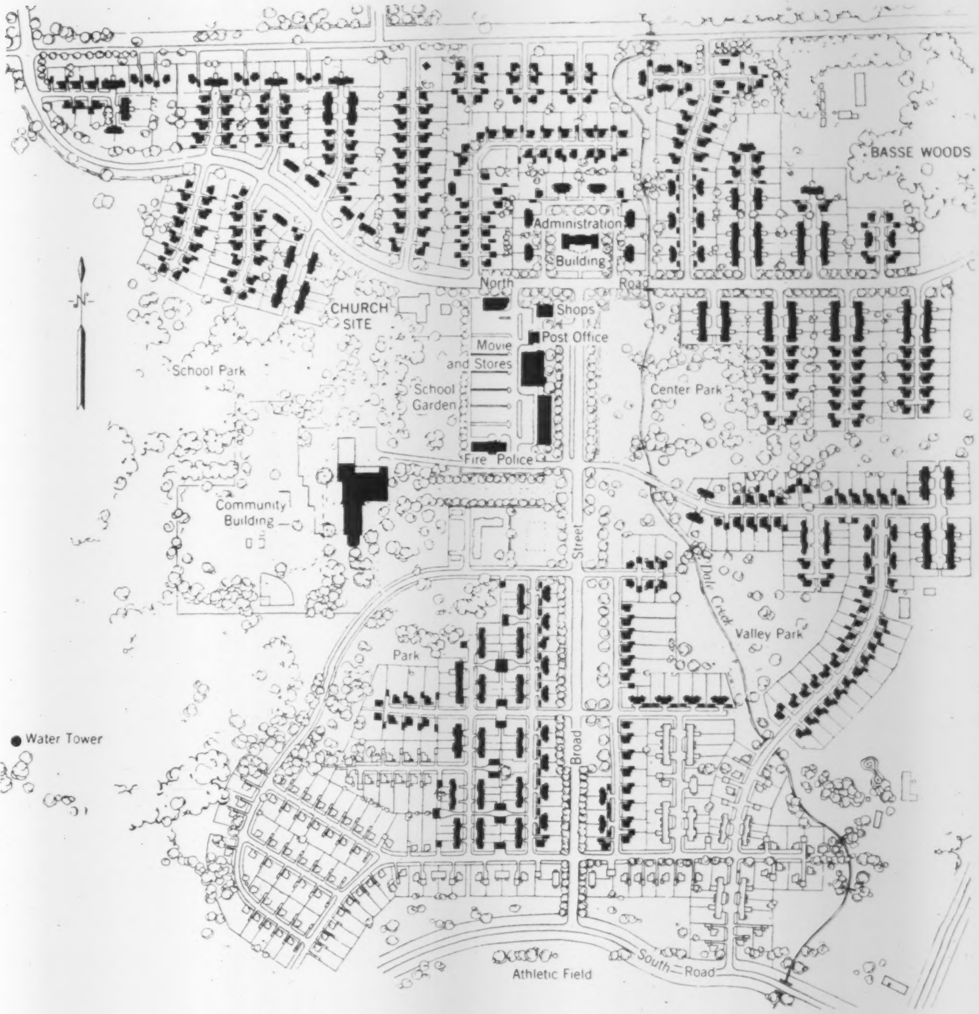


Fig. 1. Plan of the Village of Greendale, Wis. Designed and Constructed by the Resettlement Administration

ated water to allow the liberated iron oxide to precipitate. Softening will be accomplished by the base exchange method.

The softening plant is of the gravity synthetic zeolite type, having a capacity for producing in 8 hours 500,000 gal of water with a controlled hardness of 6 grains per gal. The maximum rate of flow through the softeners is 1,250 gal per min—equal to the capacity of the south well. With a 28-grain calcium-carbonate hardness, about 80 per cent (1,000 gal per min) of the total capacity passes through the softener beds, which reduce it to zero hardness. The beds are sodium-rejuvenated by application of a saturated solution of common salt, and then rinsed with aerated water, which carries away the solution of released calcium and magnesium salts to the waste sewer. The softened water flows to a 100,000-gal underground storage tank where, as it enters, it is mixed with unsoftened water from the sedimentation tank and whatever lime is necessary for pH adjustment.

The 400,000-gal double-ellipsoidal elevated steel storage tank is situated on the brow of a hill about 1,000 ft west of the town. The reserve provides a one-day supply for ordinary domestic use in the event that all pumping equipment should be out of order. Pressures throughout the town vary between 40 and 85 lb. The water level in the tank is maintained between three-quarters full and full by automatic pressure-control equipment located in the south pumping station, providing a 300,000-gal reserve available for fire use.

All water mains in the distribution system are of centrifugally cast Class 150 pipe, lined with bitumastic enamel to maintain a higher coefficient of friction throughout the life of the system.

The 12-in. feeder mains are designed to carry the water at velocities not exceeding 6 ft per sec for maximum flow, and at an approximate velocity of 3 ft per sec for normal flows. These mains will eventually encircle the town, and there will be a cross-connecting feeder main running north and south through the business area, dividing the loop, with the elevated tank within the loop. At present the north, east, south, and connecting lines are laid, and are connected with well supplies at the northeast and southeast points, and with the elevated tank at the southwest point. The distribution mains are designed on the basis of the number of fire streams, at 250 gal per min, that the main can deliver between cross-connections.

The entire system is provided with gates so that not more than two hydrants are out of service at one time in the event of a shut-off. Fire hydrants, spaced not more than 400 ft apart, have two hose-nozzle outlets each, and the hydrant leads are provided with independent gates. In planning the house-service connections, the sewer and water services are arranged to enter the houses with the least run of pipe both inside and outside the buildings. Large cast-iron pipes serve the business group and all public buildings requiring large amounts of water, and copper pipe is used for house services. All water used is metered to the individual private and public consumer.

STORM-WATER AND SANITARY SEWER SYSTEMS

A complete separate system of storm sewers has been designed and constructed. All footing drains from buildings and other clear-water sources are connected to the storm sewers, whereas in most cities such unpolluted water is discharged into the sanitary sewers because of elevation requirements. Pre-cast concrete pipe, ranging from 12 to 36 in. in diameter, was used for storm sewers, and manholes and catch-basins were built of pre-cast concrete blocks. The system was designed for maximum rainfall rates of $3^1/_2$ in. per hr, with runoff coefficients varying between 0.15 and 0.70.

Storm-sewer diameters were reduced to a minimum by utilizing quick outlets into a small stream running through the town. This stream was deepened and widened to alleviate floods such as have occurred in the past, and concrete check dams were built to reduce the mean velocity to 4 ft per sec. Since the hydraulic gradient of the creek during storm flows determines the discharge

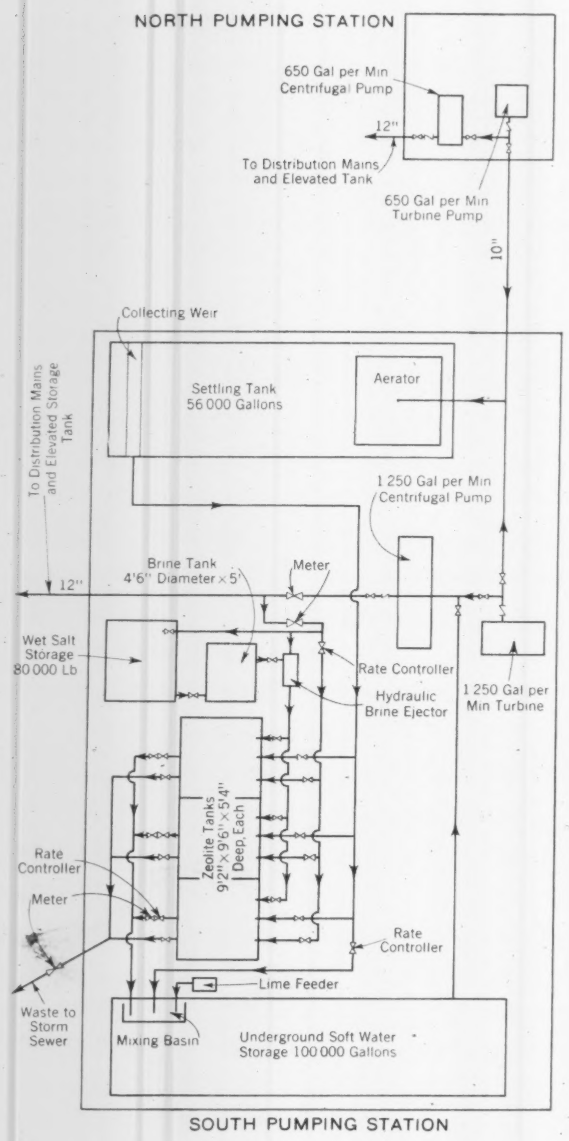

NORTH PUMPING STATION
650 Gal per Min Centrifugal Pump
12"
To Distribution Mains and Elevated Tank
650 Gal per Min Turbine Pump
10"
Collecting Weir
Settling Tank 56 000 Gallons
Aerator
To Distribution Mains and Elevated Storage Tank
1 250 Gal per Min Centrifugal Pump
Brine Tank 4'6" Diameter × 5'
Meter
12"
Wet Salt Storage 80 000 Lb
Rate Controller
Hydraulic Brine Ejector
1 250 Gal per Min Turbine
Zeolite Tanks 9'2" × 9'6" × 5'4" Deep, Each
Rate Controller
Meter
Rate Controller
Lime Feeder
Waste to Storm Sewer
Mixing Basin
Underground Soft Water Storage 100 000 Gallons
SOUTH PUMPING STATION

FIG. 2. DIAGRAMMATIC PLAN OF PUMPING STATIONS AND WATER TREATMENT PLANT

elevations of the storm sewers, selection of locations for check dams and of the cross-sectional dimensions of the stream were so coordinated with the topography as to produce optimum conditions for increasing sewer grades and thereby reducing sewer sizes.

The sanitary-sewer system has been designed to allow for sewage contribution at a maximum rate of 125 gal per capita daily, plus infiltration of ground water at 810 gal per acre per day. Vitrified-clay pipe, with cement joints made by use of a metal form and gasket, was used throughout, including all house connections, proving easy to install and efficient in minimizing infiltration.

Infiltration, as shown by gaging, amounts to only 4,350 gal daily per mile, or less than 200 gal per acre daily. It should be further reduced after the grading, paving, and landscaping operations are completed. Manholes were built of pre-cast concrete blocks. All sanitary sewage will flow to the treatment plant by gravity.

A MODERN SEWAGE-DISPOSAL PLANT

Local conditions required a high character of effluent, with freedom from odors and fly nuisances. The activated-sludge process utilizing tapered aeration was accordingly chosen. Treatment consists of comminution, primary and final sedimentation, mechanical aeration, sludge digestion, and drying.

The treatment plant (shown in Fig. 3) has a capacity of 500,000 gal per day, sufficient to meet the needs of a population of 5,000 persons. The immediate tributary population is the 572 families, or about 2,200 persons, who will occupy Greendale's first town unit. The ultimate development plan of the entire project area envisions a second town unit of about 1,100 families.

The sewage will be entirely domestic. Sewage strength and volume are estimated at 200 ppm B.O.D., 175 ppm suspended solids, and 100 gal per day per capita. Daily-flow variations were taken at 125 per cent of the average as a maximum over a 12-hour period, and 75 per cent of the average as a minimum over 12 hours.

The fenced-in area of the sewage-treatment plant includes enough land to allow expansion to treat 1,000,000 gal per day—sufficient to meet the future needs of the entire drainage district of 10,000 persons. The tank battery, approximately 96 by 61 ft, consists of four aeration tanks, two primary and two final sedimentation tanks (divided by the control-room basement), the comminutor pit, and the measuring flume. Square and rectangular tanks made the use of common walls possible. The location of the control room between the sedimentation tanks simplifies the arrangement of piping.

Plant influent will be measured by a concrete Parshall flume of rectangular cross-section, having a capacity range of from 50,000 to 1,000,000 gal per day. The flow meter and transmitter are installed in a pit adjacent to the flume. The pit will be heated by an automatic electrical space heater.

The measured influent will flow through a comminutor 10 in. in diameter having a capacity of 500,000 gal per day at a 4-in. head loss. This unit, operating intermittently by clock control (with provisions for cycle adjustment), will cut up the coarse material as the sewage flows through it, thereby eliminating the nuisance of handling screenings.

An adjustable gate-weir and bar screen installed at the inlet side of a channel around the comminutor provides for automatic by-passing for excessive storm flows or non-operation of the comminutor. The by-pass channel discharges either into the primary tank distribution channel or, in emergency, into the final effluent sewer.

The comminuted sewage flows to the rectangular primary tanks, which provide a detention period of 2 hours at average flow (21,000 gal per hr) and 1 hour and 40 minutes at the maximum flow rate (26,000 gal per hr). Either tank can be operated independently through the use of hand gates in the influent channel. The sludge-removal equipment is of the straight-line type.

After primary clarification, the sewage enters a distribution channel which is contiguous to three sides of the aeration-tank battery, connecting these tanks with one another and with the primary and secondary sedimentation tanks. This arrangement not only facilitates tank drainage, but, by proper manipulation of gates, allows (1) series or parallel operation of aerators, (2) ten different single or combination routes using one aerator or more, or (3) by-passing primary clarified sewage to final tanks without aeration.

Each of the four aeration tanks has a capacity of 47,800 gal. They are designed for the maximum 12-hour flow rate of 26,000 gal per hr. The addition of 25 per cent return sludge brings this total to 32,500 gal per hr, resulting in a 6-hour aeration period at maximum flow and $7^1/_2$-hour aeration at average flow. Return activated sludge from the sludge-division box in the control building can be introduced into any three of the aeration tanks or into the distribution channel.

Time-clock-controlled mechanical aerators will be operated on the tapered aeration principle, as developed by Carl Nordell and substantiated by Prof. Lewis H. Kessler by studies at the University of Wisconsin and at the Monroe sewage-treatment plant. The rates of oxygen utilization have been measured and plotted as characteristic curves, affording control of the treatment process in definite quantitative units of oxygen supplied.

The aerated sewage discharges into the secondary or final tanks through cast-iron pipes set in the bottom of the final sedimentation-tank distribution channel. The provided detention period, with 25 per cent return sludge, is about 1 hour and 20 minutes at the maximum flow rate and 1 hour 35 minutes at the average flow rate. The effluent is collected by aluminum "H" weir-troughs.

The control building houses the pumping equipment, sludge-division box, lime-feeder, master switchboard, laboratory, and office. Primary sludge is pumped to the digestion tank by a 50-gal per min, capacity-controlled pump. A dry chemical lime-feeder is connected to the suction side of the primary sludge pump, and this, coupled with a return pipe-line from the digester, provides for pH control of the digesting sludge. The sludge-piping arrangement makes possible drying-bed dosing from the digester by gravity or by pumping.

Activated sludge will be removed to a sludge-collecting chamber from each of the final sedimentation tanks by two sludge-withdrawal regulators with adjustable bronze weir tubes. A division box with a movable proportioning-baffle diverts predetermined amounts of sludge to the aeration tanks. Excess activated sludge is discharged into the primary-tank influent channel.

The drainage pump, which is cross-connected with the activated sludge pump for interchangeability of use, can empty any of the aeration tanks or final tanks into the distribution channel, into the effluent channel (through a locked valve), or into the primary-tank influent channel. The primary tanks are drained into the digester by the primary sludge pump.

Complete laboratory equipment is provided to make analytical determinations of sewage and sludge solids, hydrogen-ion concentrations, dissolved oxygen, biochemical oxygen demands, relative stability, sludge moistures, digester-gas constituents and heat values, and oxygen absorption. An all-steel dual-faced switchboard contains all necessary electrical controls.

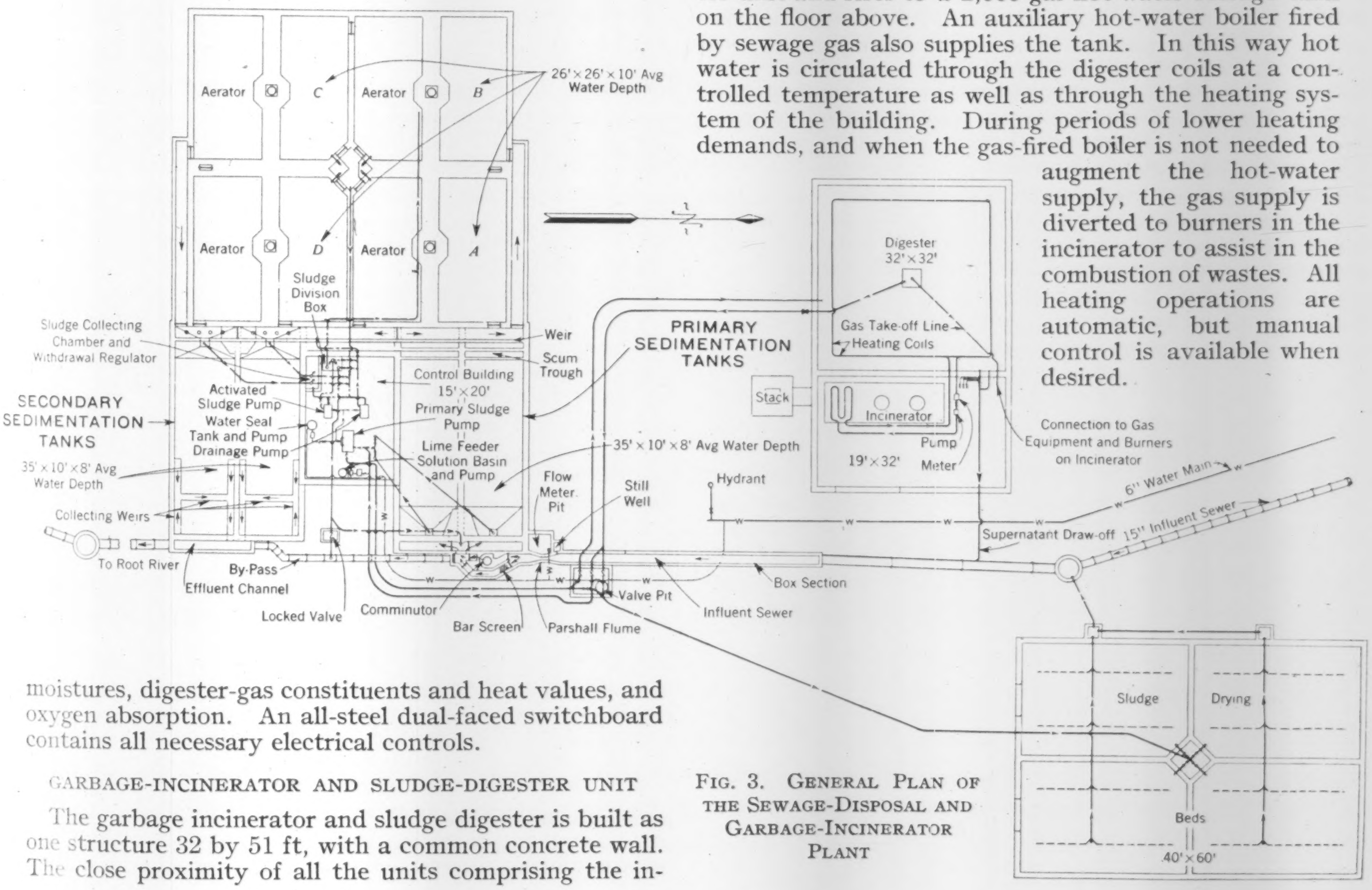

26'×26'×10' Avg Water Depth
Aerator
C
Aerator
B
Aerator
D
Aerator
A
Sludge Division Box
Sludge Collecting Chamber and Withdrawal Regulator
Weir
Scum Trough
Control Building 15'×20'
Activated Sludge Pump
SECONDARY SEDIMENTATION TANKS
Water Seal Tank and Pump
Drainage Pump
Primary Sludge Pump
Lime Feeder Solution Basin and Pump
35'×10'×8' Avg Water Depth
Collecting Weirs
Flow Meter Pit
Still Well
To Root River
By-Pass
Effluent Channel
Locked Valve
Comminutor
Bar Screen
Parshall Flume
Valve Pit
Influent Sewer
Box Section
PRIMARY SEDIMENTATION TANKS
35'×10'×8' Avg Water Depth
Digester 32'×32'
Gas Take-off Line
Heating Coils
Stack
Incinerator
Pump
Meter
19'×32'
Connection to Gas Equipment and Burners on Incinerator
Hydrant
6" Water Main
15" Influent Sewer
Supernatant Draw-off
Sludge
Drying
Beds
40'×60'

Fig. 3. General Plan of the Sewage-Disposal and Garbage-Incinerator Plant

GARBAGE-INCINERATOR AND SLUDGE-DIGESTER UNIT

The garbage incinerator and sludge digester is built as one structure 32 by 51 ft, with a common concrete wall. The close proximity of all the units comprising the incinerator-digester combination makes possible lower construction and maintenance costs. The incinerator section of the building has two floors. The basement contains the garbage-incinerator unit, supernatant sampling basin, hot-water boiler fired by sewage gas, and gas equipment. The first floor contains a washroom, hot-water storage tank, and incinerator charging holes. The one garbage-collection truck is to be housed on the charging floor when not in use. The incinerator unit is designed to burn 1,250 lb of mixed garbage and rubbish per hour—the requirements for a population of 5,000 persons at an average per capita contribution of about 1.25 lb of refuse daily, of which 28 per cent is considered as rubbish and 72 per cent as garbage. The incineration period will be 6 to 8 hours at maximum load.

Each dwelling unit has an underground galvanized-steel garbage receptacle conveniently located near the service door on the street side, eliminating the unsanitary above-ground garbage can. The inner container will have a capacity of 9 gal and will be accessible through a tight-fitting cover operated by a foot lever. The utility room of each dwelling unit will be furnished with two 30-gal cans, one for combustible refuse and the other for ashes, bottles, and other non-combustibles.

The sludge digester has a capacity of 156,000 gal, equivalent to about 4 cu ft per capita. Three 2-in. hot-water coils furnish heat to the sludge, which is to be maintained at 80 F. Four supernatant draw-off lines are provided at various levels to discharge through a common header to the influent sewer; a line connected to each of the draw-offs leads to the sampling basin. A gas take-off line conveys the gas from the dome of the digester's floating cover direct to the gas equipment.

During operation of the incinerator, water is heated in coils located in the combustion chamber of the incinerator unit and rises to a 2,000-gal hot-water storage tank on the floor above. An auxiliary hot-water boiler fired by sewage gas also supplies the tank. In this way hot water is circulated through the digester coils at a controlled temperature as well as through the heating system of the building. During periods of lower heating demands, and when the gas-fired boiler is not needed to augment the hot-water supply, the gas supply is diverted to burners in the incinerator to assist in the combustion of wastes. All heating operations are automatic, but manual control is available when desired.

The make-up water is supplied to the heating system by a tank above the storage tank, large enough to take up expansion in the system before the tank overflow operates. The only water supplied to the heating system is that required to provide for evaporation.

A glass-covered sludge bed provides an area equivalent to about $^1/_2$ sq ft per capita. The glass enclosure has two sets of side-wall sash, the top set swinging outward and the bottom set opening inward. Ridge sash are also provided. The interior is divided into four beds, which have one central sludge-dosing point. The filter bed has a 5-in. base of $^7/_8$ to 2-in. crushed stone, 4 in. of $^1/_4$ to $^7/_8$-in. gravel, and 3 in. of $^1/_{16}$ to $^1/_4$-in. torpedo-sand topping. The underdrains discharge the filtrate to the plant influent sewer.

LOOKING OUT OF A TYPICAL CUL-DE-SAC
Note That the Backs of the Houses Face the Service Drive

LATEST IDEAS EXEMPLIFIED BY ROADS AND STREETS

The design of the Greendale street system embraces traffic, collector, and minor streets. The traffic roads (the main traffic thoroughfares) have 100 and 120-ft widths with 34-ft roadways. The collector streets, which connect the minor streets with the traffic streets, are 50 ft wide with 26-ft roadways. Collector streets are so located as to discourage or eliminate through traffic. The minor streets consist mainly of short culs-de-sac having a width of 42 ft with an 18-ft roadway. Practically all the residences have their service entrances on the collector or the minor streets.

Of the seven types of road pavements considered, gravel base courses with either high-type or low-cost bituminous surface courses were finally selected as being most suitable. The base courses were placed immediately after grading, thereby affording good temporary roadways for construction traffic, which effected a thorough compaction of the gravel base during the year before the surface course was placed. For esthetic purposes, road, driveway, and sidewalk surfaces were treated as one unit and paved with the same surface material so that they will harmonize, through their dark and inconspicuous surfaces, with the landscape planting and the buildings.

Greendale has three traffic streets—two describing arcs, named "North Road" and "South Road," respectively, and one (named "Broad Street") running through the center of the town, connecting North Road and South Road, as shown in Fig. 1. Pavements on traffic streets consist of a 5-in. gravel base, a 3-in. binder course, and a 2-in. asphaltic-concrete wearing surface. Grades on traffic streets have been designed with a maximum of $5^1/_2$ per cent and a minimum of $^1/_2$ per cent.

There are about 4 miles of collector and minor streets. These consist of a $7^1/_2$-in. gravel base course and a $2^1/_2$-in. oiled-aggregate surface course. The maximum grades have generally been held at $7^1/_2$ per cent, with minimum grades at $^1/_2$ per cent. All streets have a 6 by 24-in. concrete curb, with a 6-in. curb face battered to a top thickness of 5 in. With very few exceptions, the minimum curb radius at intersections is 20 ft.

Garage drives are constructed with a 5-in. gravel base and a 2-in. graded-aggregate bituminous surface, with 2 by 8-in. treated lumber headers to be left in place along each side, set flush with the finished surface. The driveway width for a one-car garage is 8 ft, widening out to 21 ft at the curb.

Sidewalks are generally constructed with a 4-in. gravel base and a 1-in. bituminous top dressing, and have 1 by 6-in. treated lumber forms along each side set flush with the finished surface, similar to garage drives. In general, sidewalks are built on one side of the street only—the side most naturally used in going to and from school and the business center. An auto park of sufficient area to accommodate 200 cars is provided to serve the business center and the community building.

UNDERGROUND ELECTRICAL DISTRIBUTION SYSTEM USED

A completely underground system of electrical distribution was designed for Greendale, and the Milwaukee Electric Railway and Light Company will supply electrical energy over a company-built transmission line at a flat rate of one cent net per kilowatt hour. Residential service will be unmetered, a master meter being installed on the primary side of the town transformer substation. The entire system, including its companion utility, the telephone system, will be underground.

After a careful consideration of Greendale's requirements, the multiple system of street lighting was chosen. Pressed-steel standards will support upright-type luminaires, the light centers of which will be 14 ft 8 in. above the street. Lighting for residential streets will be provided by 200-w lamps on about 120-ft centers, and for main thoroughfares and the commercial area, by 300-w lamps on about 140-ft centers. The lights will be actuated by a photoelectric cell.

Eight strategically located fire-alarm pull boxes will control two electric sirens, together having an audibility of 1,000 ft. The sirens are located on the roof of the fire station and will serve to call volunteers. An annunciator at the station will indicate the source of the alarm.

The development of Greendale has presented many interesting phases. Chiefly, the constant thought has been economy—not in the sense of initial cheapness but in final cost throughout the years.

In one sense, the development of this meadow into a modern village, where none had existed before, naturally called for hypothetical assumptions not generally met with in an established community. On the other hand, the fact that the character and use of the entire community was predetermined, could be taken full advantage of, thus permitting a more intelligent design for the various utilities which go to make up a modern town.

The senior author headed the engineering staff, and with the co-author was in direct charge of the design of the sewerage works. Assistants on the various major phases of the work included Elmer W. Becker, water works engineer; Frank O. Miller, structural engineer; Raymond F. Stein and Charles W. Matthews, Assoc. M. Am. Soc. C.E., road engineers; Francis P. Quigley, electrical engineer; Joseph N. Lacy, utilities architect; and Ervin Greenbaum, Jun. Am. Soc. C.E., associate civil engineer.

The Manufacture of Asphalt

Production Processes and Physical Characteristics of Principal Commercial Forms

By Gene Abson

Chemical Engineer, Chicago Testing Laboratory, Inc., Chicago, Ill.

ASPHALT is one of the world's oldest and most useful materials of construction. Although utilized in minor ways by the early civilizations, it attained widespread recognition only within comparatively recent years, following the discovery that the volatile components of certain crude petroleums can be removed by distillation, leaving asphalt residues. This operation was first carried out in cylindrical "shell" stills, and was periodic in character. It was later replaced by the continuous distillation process, employing tube or pipe stills for heating the crude oil and drums connected to fractionating towers, into which the various components are vaporized. The transformation that takes place in distillation is purely physical in nature. Oxidation, the only other common method of asphalt manufacture, involves bringing hot residuum into contact with air, and effects a chemical transformation. Asphalt production by the use of oxidation is largely by the batch method at present, although continuous air-blowing processes are being developed. Mr. Abson's article concludes with a discussion of the proper characteristics of asphaltic products for use in paving and in roofing work—valuable data for the specification writer.

AMONG the earliest applications of asphalt were its use as waterproofing and for preservation against the elements, as for example in the encasement of mummies in the Egyptian era, the "pitching" of Noah's Ark, and the waterproofing of the basket of Moses. Another use was as a cementing medium in ancient works of art, as mentioned in many biblical references and confirmed by recent archeological discoveries. These asphaltic materials were obtained, of course, from natural deposits, since there was no knowledge of petroleum oil or its refining.

The first use of asphalt-impregnated limestone deposits for the construction of sidewalks and bridge floors occurred in Europe about 1800, and in the United States about 1838. These materials were first used in the construction of heated and compressed roadways or streets in Paris in 1854, in London in 1869, and in Newark, N.J., in 1870. The "rock-asphalt" deposits were in reality oil-impregnated beds of limestone or sandstone in which the oil, by exposure to pressure through long periods had been metamorphosed into a soft asphaltic material.

The first synthetic asphalt pavement—the forerunner of the present-day "sheet-asphalt" and "asphaltic-concrete" pavements—appeared in Washington, D.C., in 1879. For this work the asphaltic binder was made from Trinidad asphalt (an asphalt occurring naturally in association with finely divided siliceous mineral matter) softened with a residue (flux) from petroleum distillation. Fortunately, since cement made from Trinidad asphalt is a highly satisfactory paving material, the resulting pavements far surpassed the "rock asphalts" and very soon almost entirely displaced them. Later, with the discovery of asphalt-bearing crude oil, from which refined asphalt could be obtained by distilling off the lighter parts, Trinidad asphalt was gradually displaced, and today it represents a very minor fraction of the total consumption of asphalts.

The first use of asphalt in the construction of roofs (including built-up roofing and roofing of impregnated and coated paper felt) took place about 1870, the asphalt being substituted for the pine-tar and coal-tar pitches previously used. This use of asphalt spread rapidly, and today it has become a major industry, consuming over a million tons annually.

Following the discovery that "fluxes" for Trinidad asphalt could be obtained from the residues of the distillation of crude oils, came the further discovery that certain crudes (notably those of California) could be further distilled, leaving residues of varying degrees of hardness. With improvements in technique and with the use of steam (to prevent local overheating in the stills as well as to lower the distillation temperature), it soon became possible to manufacture pure petroleum asphalt of almost any desired hardness or "penetration."

CONSEQUENCES OF DISCOVERY OF DISTILLATION

Practically all the asphalt produced today is manufactured by the distillation of petroleum oil—either crude oil or oil which has been "topped" in a previous distillation operation—sometimes followed by an oxidation process to produce certain desired characteristics, or to produce certain properties for a particular purpose.

Petroleum is a complex mixture of hydrocarbons, ranging from the lowest-boiling, simple, straight-chain molecules (occurring in the lightest gasoline fractions) to the unknown non-volatile molecules which occur in asphalt. Between these extremes are many different types of hydrocarbon molecules. Asphalts have been very roughly classified into groups of hydrocarbons by selective solubility in arbitrarily designated solvents, but almost nothing is known about their chemical compositions or physical combinations. A great deal of work on this complicated problem is going on in research laboratories throughout the country, but progress is necessarily slow.

All distillation processes in the manufacture of asphaltic products give the same end product. Distillation is simply the progressive vaporization and removal of volatile components as they change from liquids to vapors under the influence of heat. This is essentially a physical change, but a minor chemical change does take place in the polymerization or aggregation of the molecules, forming more complex molecules. Since all petroleums are mixtures of more or less volatile, mutually soluble organic compounds, they are for the most part readily fractionated when heated to vaporizing temperatures. The final hard, asphaltic residues are not volatile under ordinary refinery conditions. On the contrary, they would eventually decompose into their constituent elements of hydrogen and carbon (with small amounts of sulfur, nitrogen, or oxygen) as a result of their exceedingly high boiling points, rather than change to the vapor phase.

The first distillation processes were carried out by the

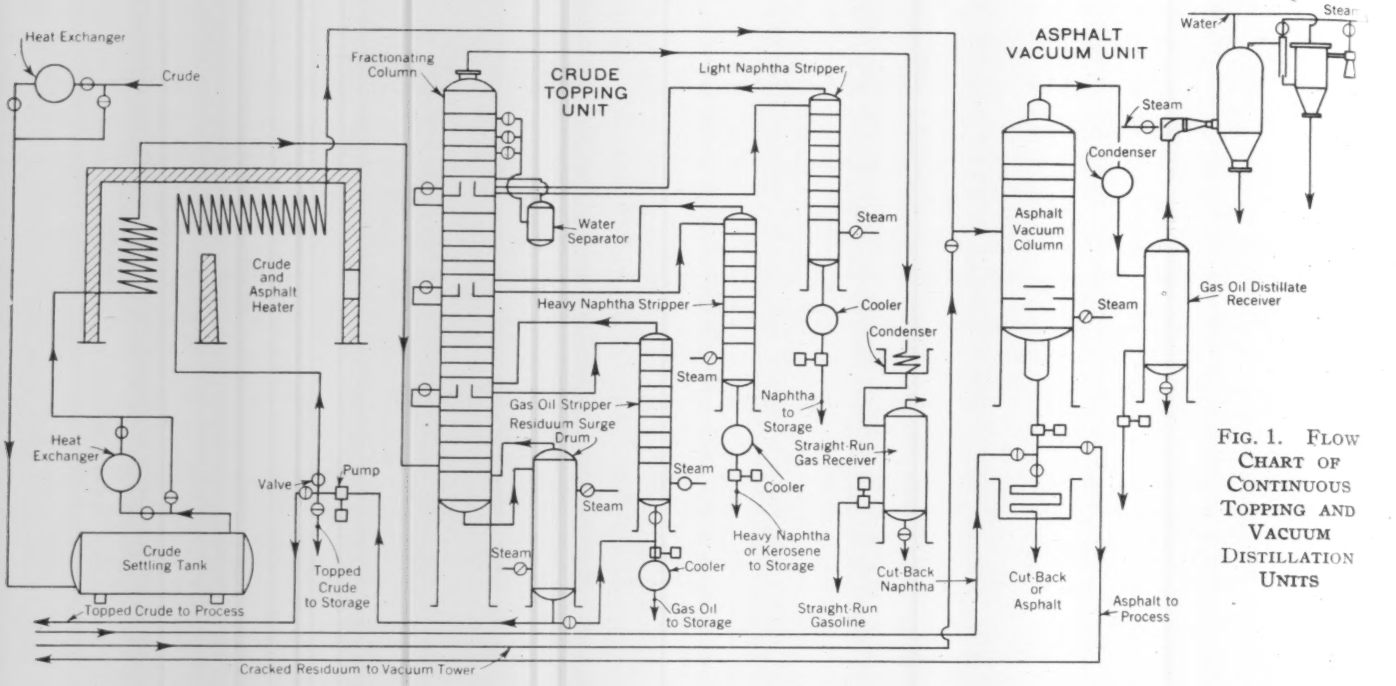

Heat Exchanger
Crude
Fractionating Column
CRUDE TOPPING UNIT
Light Naphtha Stripper
ASPHALT VACUUM UNIT
Water
Stea
Steam
Condenser
Water Separator
Crude and Asphalt Heater
Steam
Asphalt Vacuum Column
Heavy Naphtha Stripper
Cooler
Condenser
Steam
Gas Oil Distillate Receiver
Steam
Naphtha to Storage
Gas Oil Stripper
Residuum Surge Drum
Straight-Run Gas Receiver
Heat Exchanger
Pump
Valve
Steam
Steam
Cooler
Heavy Naphtha or Kerosene to Storage
Crude Settling Tank
Topped Crude to Storage
Steam
Cooler
Cut-Back Naphtha
Cut-Back or Asphalt
Asphalt to Process
Topped Crude to Process
Gas Oil to Storage
Straight-Run Gasoline
Cracked Residuum to Vacuum Tower

FIG. 1. FLOW CHART OF CONTINUOUS TOPPING AND VACUUM DISTILLATION UNITS

batch method in cylindrical "shell" stills set in brickwork and fired from below. Crude oil or topped residues were used as the charging stock, and the overhead products were removed by gradually raising the temperature until the desired consistency of the residue was reached. It was found that by injecting steam through perforated pipes placed along the bottom of the still, distillation could be carried on at much lower temperatures. These temperatures depend upon the quantity of steam used and its partial pressure effect in reducing the temperature necessary for vaporization. Later, continuous batteries of shell stills were developed to make the process semi-continuous. One of the photographs shows a battery of such stills, equipped with modern vacuum sections and "bubble towers" or fractionating columns.

DEVELOPMENT OF CONTINUOUS DISTILLATION PROCESS

These batch operations, however, were relatively slow. The development of tube or pipe stills for heating crude oil and the discharge of the heated oil into vaporizing drums, connected with fractionating towers, later made possible the continuous distillation method for the processing of asphalts. Steam was introduced to aid vaporization in the drums, and vacuums were produced for lowering the temperature and reducing the time of vaporization. The rate of heat transfer through pipe stills is high, and the time during which the oil is subjected to maximum temperatures is a matter of seconds compared with periods of hours in the case of shell-still operation. As a consequence, higher temperatures can be used without causing "cracking" or decomposition, permitting the processing of asphalt-containing crudes which could not have been separated in shell stills without decomposition.

The modern tube still and vacuum tower consists simply of an interconnected series of pipes or tubes mounted in a furnace. The oil is pumped through the tubes until it attains the temperature necessary to produce vaporization, and is then discharged into an upright drum in which atmospheric or less-than-atmospheric pressure is maintained. The oil, coming in at a relatively high temperature, is immediately flashed into vapor and residue, as a result of the release of pressure. The residue is continuously withdrawn from the bottom of the tower and the vapors are removed through the top, later to be condensed and utilized. The consistency of the residue is governed by the maximum temperature reached in the furnace and by control of the pressure reduction and the amount of steam present. The higher the temperature and the lower the pressure (or the higher the vacuum), the more material will pass out as vapor, leaving a harder residue. A "dry" vacuum (that is, one without steam) can be used, but as this must be a vacuum of 10 mm or less, it is not as economical as is a 30- to 50-mm vacuum supplemented by steam, since the steam exerts its partial pressure effect in reducing the vaporizing temperature of the incoming oils.

By proper arrangement of the tubes in the various parts of the furnace, the rate of temperature rise, and the time of subjection to maximum temperatures can be closely controlled. The tubes ordinarily are about 4 to 5 in. in diameter, and large furnaces frequently contain 150 or more such tubes 30 ft in length. Thus there is almost a mile of heating tubes in each furnace, capable of handling over 200,000 gal of asphalt per day—ten times the volume of the largest batch operation.

A flow diagram of one of the latest refinery installations for asphalt manufacture appears in Fig. 1. The equipment shown here consists of a pipe-still and fractionating-tower unit operated under atmospheric pressure for topping the crude oil, and a vacuum unit for separating the asphalt from the topped residue. The overhead distillates from the topping unit—the gasoline, naphthas, and gas oil—are transferred to a contiguous "cracking" unit for the production of high-anti-knock gasoline. Asphalt of any desired penetration range is continuously removed from the bottom of the vacuum tower to be processed, or it may be continuously blended with various grades of naphthas to produce "cut-back" asphalts. The characteristics of the final product are functions of both the temperature and the degree of vacuum maintained. For harder products, it is only necessary to take off a higher percentage of distillate, and this can be accomplished by using higher temperatures, operating under greater pressure reduction, or using more steam; or by combining all three. Conversely, softer grades of asphalt or flux oils may be produced by removing a lesser amount of distillate. Proper correlation of these factors permits the direct manufacture of asphalts as hard as 30 to 40 penetration, or within the customarily designated ranges of 40 to 50, 50 to 60, 60 to 70, and 85 to 100 or upwards to any softer degree, as measured by the A.S.T.M. standard test for hardness.

THE OXIDATION PROCESS

The only other commonly used method for manufacturing asphalts is oxidation or "air-blowing." This process involves bringing the hot residuum or asphalt into contact with the air, resulting in a chemical reaction instead of a physical transformation such as occurs in distillation. The most usual type of apparatus is a cylindrical shell still of the batch type, mounted either horizontally or vertically. The air is forced through perforated pipes, which are situated along the bottom of the still like the steam pipes in the steam distillation process. The air need be under no greater pressure than that necessary to overcome the static head of the material in the still and to cause intimate contact and agitation. The quantity of air used averages about 20 to 30 cu ft per ton of asphalt processed; the temperatures ordinarily used are in the neighborhood of 400 to 500 F; and the reaction is exothermic, necessitating very little, if any, external heat after the reaction has started. The charging stock may be any liquid residue or semi-solid asphaltic material which has previously been distilled to remove the more volatile fractions and to bring the flash point to upwards of 400 F. In other words, crude oils are never used.

On account of the comparatively low temperatures used, this process is essentially one of non-distillation. The oxygen of the air combines with part of the hydrogen in the hydrocarbon molecules (forming water which is removed as steam), and the hydrocarbon molecules join each other to form larger, denser compounds of higher molecular weight. This is known by such various terms as condensation, polymerization, and aggregation. The continued application of air hardens the charging stock, yielding asphalts of progressively decreasing penetrations and higher softening points. The time required varies from a few hours to 24 or more, being a function of the final hardness desired as well as of the type of charging stock. Continuous processes for air-blowing are being developed, but at present most of the production is by the batch method.

TABLE I. COMPARISON OF DISTILLED AND AIR-BLOWN ASPHALTS MADE FROM THE SAME CHARGING STOCK

Mexican Residuum Refined by Laboratory Batch Method

ITEMS	RESIDUUM USED	STEAM-REFINED	AIR-BLOWN
Specific gravity at 77 F	0.996	1.047	1.017
Flash point, Cleveland open cup, in deg F	410	570	460
Solubility in carbon disulfide, in %	99.9	99.9	99.9
Solubility in carbon tetrachloride, in %	99.9	99.8	99.8
Penetration at:			
77 F (100 g, 5 sec)	...	55	56
32 F (200 g, 60 sec)	...	18	31
115 F (50 g, 5 sec)	...	260	123
Ductility at:			
77 F (5 cm per min), in cm	...	100+	4.0
39.2 F (5 cm per min), in cm	...	5.0	...
Softening point, ring and ball method, in deg F	...	128	157
Spot test (oliensis)	Neg.	Neg.	Pos.
Yield, in %, by weight	...	65	96

There are very distinct differences between the asphalts produced by the two processes. The distilled products are more susceptible to temperature changes, have a lower melting point for any given hardness, and are more ductile and more adhesive (when used in thin films as a binder) than are the oxidized asphalts. Paving asphalts are for the most part non-oxidized products, whereas roofing asphalts are almost all oxidized, particularly the coating grades. In between are all combinations of partially oxidized and partially distilled products. In Table I is a comparison of the products of the two methods, using the same charging stock. Table II gives typical analyses of air-blown asphalts produced for several different uses.

TABLE II. TYPICAL ANALYSES OF AIR-BLOWN ASPHALTS FOR VARIOUS USES

	ROOFING ASPHALTS			BRICK FILLERS			SEALING AND COATING		
ITEMS	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Penetration at:									
77 F (100 g, 5 sec)	16	20	24	38	52	50	75	15	40
32 F (200 g, 60 sec)	10	14	15	25	30	26	50	12	37
115 F (50 g, 5 sec)	29	36	44	70	119	96	131	19	58
Ductility at 77 F (5 cm per min) in cm	4	3	..	4.5	4	46	2	1	1
Specific gravity at 77 F	..	1.03	1.01	1.005	1.18	..	0.980	1.044	..
Softening point (ring and ball method), in deg F	228	225	190	178	160	172	185	265	218
Flash point (Cleveland open cup), in deg F	505	500	610	495	450	415	510	495	525
Solubility in carbon disulfide, in %	99.8	99.7	99.7	99.8	99.9	99.7	99.9	99.6	99.8

Sources of Residuum:

(1) Colombian and Mexican	(4) Gulf Coast	(7) Mid-Continent
(2) Gulf Coast and Mexican	(5) Mexican	(8) Mexican
(3) Mid-Continent Pipe Still	(6) Mid-Continent and West Texas	(9) Smackover

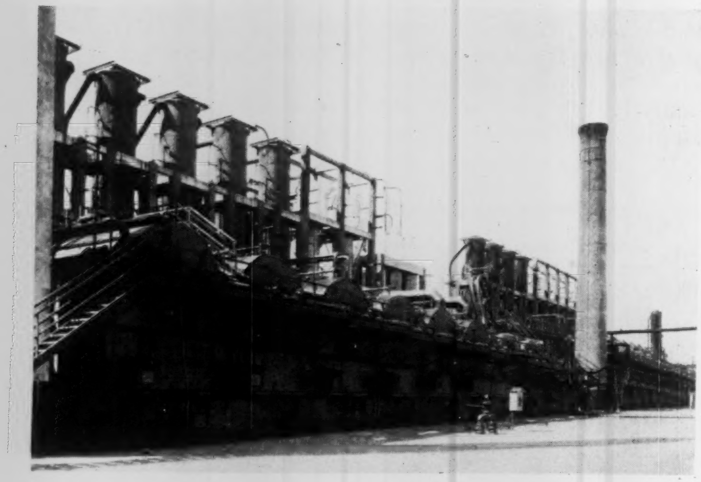
Natural asphalts (represented mainly by Trinidad, Bermudez, and Gilsonite asphalts) are refined only to the extent of removing the water and gas (when present) and then (usually) softening to the desired penetration by "fluxing" with a liquid or semi-liquid petroleum oil. Gilsonite is primarily used in paints and varnishes, but also to some extent (in powdered form) in the construction of "cold-mix" asphalt pavement.

Road oils, while not classified as asphalts, are nevertheless akin to them, particularly in the form used for road construction. The heavier grades of road oils, produced from asphaltic types of crude petroleum, are residues from distillations which have not progressed as far as in the manufacture of asphalt. Some of the heavier grades are used interchangeably with cut-back asphalts in the construction of secondary-type roads. The volume used in 1936 amounted to over 300 million gallons (over 1.25 million tons).

When asphaltic materials are used, they are almost always in a fluid or semi-fluid state, produced either by the application of heat, by "cutting-back" with more or less volatile diluents, or by emulsification with water. In the manufacture of asphalt roofing materials, the felts are saturated with hot asphalt and the coating layer is likewise applied in a heated, fluid condition, whereas roofing cements and plastic cements are usually cut-back materials applied cold.

FOR "HOT-MIX" AND PENETRATION MACADAM

The highest grades of asphalt pavements are the so-called "hot-mix" compositions, such as sheet asphalt or asphaltic concrete. In these types the asphalt is added hot to the hot mineral matter (filler, sand, and stone). The constituents are then mixed and transported, the mixture being spread and rolled while still hot. Pavements of this kind usually contain between 5 and 10 per cent of asphalt by weight. The remainder in the case of sheet asphalt is pulverized mineral filler and carefully graded sand; for asphaltic concrete, it is filler, sand, and crushed stone. The asphalt cement used in "hot-mix" pavements is always produced by steam or vacuum refining, although some oxidizing may have been used in the final stages of refining for the purpose of reducing susceptibility to temperature changes.



BATTERIES OF SHELL STILLS, PORT NECHES REFINERY OF THE TEXAS COMPANY

The Battery in the Foreground Consists of Six Atmospheric Stills with Bubble Towers and Five Vacuum Stills with Baffle Towers

The grades of asphalt used are designated by their hardness, expressed in penetration ranges. In the A.S.T.M. standard penetration test, consistency or hardness is measured by the depth of penetration, in tenths of a millimeter, of a sharp-pointed standard needle, loaded with a 100-g weight and allowed to penetrate for a period of 5 sec into a sample of asphalt maintained at 77 F. The grades customarily used are within the ranges of 40–50, 50–60, 60–70, and sometimes softer (the ten-point range being designed to allow for testing and refinery-control limitations). Table III shows analyses of several typical varieties of asphalt cements used in "hot-mix" work.

The next highest type of asphalt paving is that known as "penetration macadam" or "asphaltic macadam." The asphalts used in penetration type work are very similar to those used in hot-mix work with the exception that the penetration at 77 F is usually from 85 to 100. Here a layer of crushed stone, graded from large to small, is spread upon a foundation and compacted by rolling. Then asphalt cement of 85–100 or 100–120 penetration is applied hot to the surface by pressure distributors, and allowed to penetrate the interstices between the stones and at the same time to coat the exposed surfaces. Smaller stone is then applied and rolled to "key" together the larger aggregate; more of the same hot asphalt is applied; and finally a surface layer of chips is spread. Cut-back asphalts and emulsified asphalts of the "quick-breaking" type may also be used in this kind of construction. With emulsions, the voids in the combined aggregate must be smaller, because the emulsions are very thin fluids and would drain away otherwise. Since both cut-backs and emulsions are fluid at atmospheric temperatures, they are applied without heating. Table IV shows characteristics of a typical emulsion used in this type of construction.

A third type of use is exemplified by the various methods of building secondary roads and surfacing lighter-traveled highways. The wearing surfaces involved are said to be constructed of "road-mix," "mixed-in-place," "retread," "oil-mix," and "plant-mix." There is much confusion between the terms used, and often the same term has different meanings in different sections of the country. Perhaps the best differentiation is based on a division of the methods into two classes, in which the terms are related to the thicknesses of the compacted surfaces. On this basis it has been proposed to call treatments resulting in wearing courses of one inch or over in thickness "road-mix" surfaces, and all those of less than one inch, "surface treatment." The asphaltic materials used include cut-backs of every type, emulsions of all varieties, and residuals of all sorts from heavy oils to asphalts.

TABLE III. TYPICAL ANALYSES OF ASPHALT CEMENTS USED IN "HOT-MIX" WORK

ITEMS	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Penetration at:							
77 F (100 g, 5 sec)	45	52	45	54	50	75	52
32 F (200 g, 60 sec)	14	14	13	11	16	20	19
115 F (50 g, 5 sec)	212	290	240	350+	225	400+	330
Ductility at:							
77 F (5 cm per min), in cm	150+	150+	150+	150+	150+	150+	150+
39.2 F (5 cm per min), in cm	...	...	...	...	...	7.4	5.3
Specific gravity at 77 F	1.012	1.026	1.029	1.020	1.040	1.019	1.041
Softening point (ring and ball method), in deg F	130	129	128	124	135	...	...
Flash point (Cleveland open cup), in deg F	600	660	680	565	530	560	530
Maintaining 50 g for 5 hr at 325 F:							
Loss, in %	0.04	0.02	0.04	0.02	0.02	0.06	0.02
Penetration after loss	44	45	42	52	45	68	47
Percentage loss in penetration	2.2	13.5	6.7	4.0	10.0	9.3	9.6
Fixed carbon, in %	...	16.1	15.9	11.0	16.3	...	...
Solubility:							
In carbon dilsulfide, in %	99.9	99.7	99.8	99.9	99.9	99.9	99.9
In carbon tetrachloride, in %	99.8	99.7	99.8	99.9	99.9	99.9	99.9
In 86° (A.P.I.) naphtha (hexane), in %	77.8	78.7	78.5	89.8	71.2	...	...
Spot test (oliensis)	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Furol viscosity at 275 F, in sec	...	...	...	...	...	225	445
Fluidity factor	...	...	...	...	...	113	204
Sulfur, in %	...	...	...	...	...	3.29	5.79

Sources of Residuum and Processes Used:

(1) Mid-Continent; pipe still and vacuum tower; some oxidation
(2) Smackover; pipe still and vacuum tower; some oxidation
(3) West Texas and Mid-Continent; steam, batch still (laboratory)
(4) California; batch, steam, no oxidation
(5) Mexican; steam, continuous (no oxidation)
(6) Venezyelan; continuous, vacuum
(7) Mexican; continuous, vacuum

PRE-LIQUEFIED ASPHALTIC PRODUCTS

In addition to all the asphalts previously described, a considerable quantity of pre-liquefied asphaltic products is used in road construction. These are cut-backs composed of heavy residual oils or asphalts, and are liquid at temperatures normally used, but revert to their original base consistencies after exposure in thin films, by evaporation of the diluent. Cut-backs are manufactured products in which fluidity is obtained by dilution

TABLE IV. ANALYSIS OF A TYPICAL EMULSION USED IN THE PENETRATION TYPE OF CONSTRUCTION

ITEMS	DATA
Furol viscosity at 77 F, in sec	48
Residue by distillation, in %	59.7
Settlement in 5 days, in %	0.5
Demulsibility, 35 ml, 0.02 N $CaCl_2$, in %	87.5
Retained on No. 20 sieve	Trace
Residue from distillation:	
Specific gravity at 77 F	1.007
Penetration at 77 F	145
Ductility at 77 F (5 cm per min), in cm	100+
Solubility in carbon disulfide, in %	99.9
Ash, in %	0.2

or fluxing, rather than by heating. As a consequence, they may be applied to the road or to mineral aggregate surfaces without the necessity for heating the aggregate, and they also allow a longer time during which manipulation can take place.

Cut-backs are made for many purposes, among which may be mentioned primers, seal-coats, carpet-coats, and road- and plant-mixes (in which the aggregates may be open-graded or dense-graded, with or without sand or filler). Consequently there must be a wide variety with regard to original viscosity, consistency of base after evaporation, and rapidity of volatilization of diluent. The diluents are usually naphthas, kerosenes, or light gas-oils. Diluents need not be refined to any rigid standards of color or odor or to an extremely narrow range of boiling points, since they eventually disappear.

As there have been a multiplicity of specifications and overlapping of grades of cut-back asphalts for various uses, attempts have been made to standardize the products on the basis of rapid-curing, medium-curing, and slow-curing grades, the primary differences being in the volatility of the distillate used for cutting-back. Within each individual grade the viscosity is controlled by the percentage of diluent added, and may range from that of a fluid such as water, to a very heavy consistency which requires warming before application.

Cut-back asphalts are also used for such purposes as water-proofing, roofing, paints and japans, fibrous cements, and coatings. The asphalt-cement bases for these products are usually harder than the highway materials and frequently utilize blown asphalts.

Emulsions (emulsified asphalts) are physical combinations of water and asphalt, in which the asphalt is mechanically dispersed in very minute globules suspended in the water medium and prevented from coalescing by the presence of an emulsifying agent. In these bituminous emulsions fluidity is attained by using water as the liquefying means in place of heat or solvents.

The manufacture of asphaltic emulsions for paving uses began as early as 1905, but only within the last few years have emulsions become an important part of the industry. This reawakening was coincident with the commercial development of paving emulsions in which the "rate of break" could be controlled. Commercial development and perfection of emulsions has also progressed rapidly for use in waterproofing, paints and coatings, paper and board manufacture, and insulating and sound-proofing.

The paving and the industrial types of emulsions are markedly different in method of manufacture and materials used. The road emulsions are normally of the soap type, using asphalts generally softer than 100 penetration, while the industrial type use inorganic mineral powders (such as colloidal clays) for the emulsifying agent, and steam-refined asphalts of relatively hard penetration.

The apparatus for manufacturing road-type emulsions is usually some form of colloid mill, an adaptation of the mill principle, or batch agitator, whereas the industrial emulsions require a specially designed emulsifier. Both kinds of emulsions are of the water-external-phase type, which means that they are further dilutable with water and are non-adhesive until the water is expelled or the emulsion "breaks." The asphalt-external type of emulsion is, of course, possible, but it is rarely used since it would be viscous and adhesive even before "breaking."

In addition to the soaps and colloidal clays, a vast number of other emulsifying agents are used, both organic and inorganic. Combinations of agents are used for particular purposes, such as to control sensitiveness to electrolytes and to permit mixing with fillers or fine mineral particles. Some emulsions are made without adding a protective colloid, by taking advantage of the fact that certain asphalts contain sufficient naphthenic acids or other saponifiable constituents to form an emulsifying agent in situ upon the addition of an alkali to the water. The rate of "breaking" of the road emulsions is usually a function of the amount and kind of protective colloid present, the "slow-breaking" type containing the higher percentage.

Oxidizing Tanks for Producing Air-Blown Asphalt, with Loading Rack of 65-Car Capacity

In the Bayonne Refinery of the Standard Oil Company of New Jersey

The manufacture of emulsions, while not exceedingly intricate, is still not simple, and therefore each producer very carefully guards as a trade secret the amount and type of emulsifying agent used, as well as the stabilizer for mixing emulsions. There are numerous patents covering both the materials and the processes used.

TWO TYPES OF EMULSIONS USED IN ROAD CONSTRUCTION

Emulsions in road construction are classed under two broad types—"quick-breaking" and "mixing." The mixing types of emulsion are divided into several grades, each having a different stability towards electrolytes encountered in mixing with mineral aggregates. This rate of "breaking" refers solely to the reactions of the emulsions toward mineral aggregates when spread in thin films; under ordinary conditions of shipment and storage, emulsions are all extremely stable, and some types are able to withstand freezing when suitably treated. They are adapted to a wide range of usefulness, being satisfactory for use in almost all types of bituminous road construction. In low-cost road construction they are especially adaptable for use in moist climates or during wet weather because they can be applied to moist or damp aggregates.

Commercial road emulsions normally contain 55 to 75 per cent asphalt and 0.5 to 3 per cent of emulsifying agents, the remainder being water. They range in fluidity from the viscosity of water to that of thick molasses, as the percentage of asphalt increases. The process used in the refining of the asphalt sometimes calls for special consideration in the manufacture of emulsions, but no matter from what source the asphalt may be derived, its successful use depends upon skillful employment of methods, apparatus, and emulsifying agents.

Machines and Methods for Canal Construction, Colorado River Aqueduct

Ingenious Subgrade-Trimmers and Pavers Perform Rapid and Accurate Work

By W. L. CHADWICK, M. AM. SOC. C.E.
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ENGINEER, THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

LINING of the last of the 62.8 miles of open canal required for the Colorado River Aqueduct was completed in March 1937, twenty-nine months after the award of the first contracts for this class of work. Although the canal is not of unprecedented size, its great extent and the rapid rate of construction required have led to the development of new methods and equipment of particular interest to engineers. The accompanying article by Messrs. Chadwick and Archibald deals with construction of the open canal, with special attention to the design and operation of the huge machines developed by the contractors for trimming subgrades and for placing concrete. It is expected that similar articles dealing with the Cajalco Reservoir and possibly also with the cut-and-cover conduit and the siphon sections of the aqueduct will be available for future issues of "Civil Engineering."

THE Colorado River Aqueduct is being built to carry a peak flow of 1,605 cu ft per sec of Colorado River water to Los Angeles and 12 other cities in metropolitan Southern California. Construction was started late in 1932 and has continued without interruption. The 242-mile main aqueduct diverts water from the river above Parker Dam, 155 miles below Boulder Dam, and with its 176-mile distribution system stretches entirely across the southern part of California. In addition to the 62.8 miles of canal, 54.5 miles of cut-and-cover conduit, and 28.7 miles of siphons, aqueduct structures include the diversion dam and distribution system previously mentioned, as well as 92.1 miles of lined tunnel, a large terminal reservoir, three auxiliary reservoirs, and five large pumping plants. A 237-mile, 230,000-v transmission system supplies low-cost power from Boulder Dam to the pumping plants. The aqueduct system and various phases of its construction have already been described, in CIVIL ENGINEERING for May 1934, February 1935, September 1935, and August 1937. Maps are included with the first two of these articles.

The cost of each of the three principal conduit types—*i.e.*, open canal, cut-and-cover conduit, and tunnel—varies with the topography of the region and with the fall available for the production of flow. The latter factor is particularly important because of the necessity for pumping. By balancing the cost of pumping against the cost of conduit construction, it is possible to select a correct size for each type and physical condition. (See *Engineering News-Record*, January 28, 1937, "Aqueduct Size and Slope" and March 25, 1937, "Economic Sizes of Pressure Conduits," both by Julian Hinds, M. Am. Soc. C.E.)

Under average conditions and with proper slopes, the costs per foot of canal, cut-and-cover conduit, and dry tunnel are about in the ratio of 1:2:4. Economic slopes for these three kinds of structures are in the ratios of 1: 3: $4^1/_3$. Consequently, for economy of both first cost and pumping expense it was important to use, as conditions permitted, first, canal; second, conduit; and then tunnel. However, the security of the three types after completion is approximately proportionate to their costs, tunnel construction being the least subject to damage from the elements and canal the most subject to such damage. The evaluation of all these factors of cost, practicability, and safety has led to the selection of types in the lengths previously mentioned.

CHARACTERISTICS OF OPEN CANAL

A cross-section of the normal canal in earth and a number of its hydraulic properties appear in Fig. 1. A roughness coefficient of 0.014 was assumed in design, but with the excellent surface finish secured it is thought that this factor will be bettered by one point, at least.

Lining thicknesses are greater than those generally used in irrigation practice, in order to assure permanence and dependable continuity of operation. The lining contains 0.5 per cent of high-elastic-limit steel longitudinally, designed to control the spacing and size of shrinkage cracks. Reinforcement is continuous and all bars are of rail steel. There are no expansion joints.

The berms at the top of the lining are designed to prevent ravel, from the slopes and spoil banks, from entering the canal. For maintenance purposes, a roadway was constructed along the entire length of the canal, on the downhill side.

Approximately 2,000 lin ft of canal was constructed in rock. The finished bottom width of canal in rock is 12 ft, the depth is 12.05 ft, and the hydraulic gradient, 0.00025.

In the desert area which is crossed by the eastern part of the aqueduct, water for construction may be had only

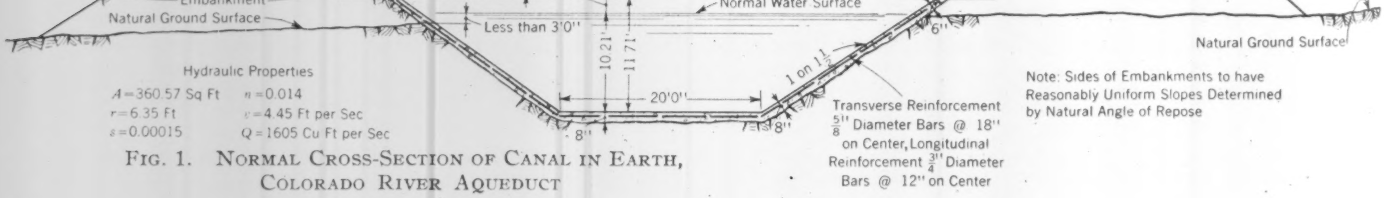


FIG. 1. NORMAL CROSS-SECTION OF CANAL IN EARTH, COLORADO RIVER AQUEDUCT

y pumping long distances. Summer temperatures are high and humidities very low, making concrete curing a difficult problem.

Before any construction specifications were written, a careful research determined that the most economical and satisfactory curing would result from applying, on all exposed surfaces, coal-tar-pitch cutback, composed of 75 per cent refined coal-tar pitch, thinned to a sprayable consistency by 25 per cent of coal-tar naptha solvent. It is applied in two coats, followed by two coats of whitewash to reduce heat absorption. The latter material consists of not less than 65 per cent calcium and magnesium oxides, 17 to 20 per cent anhydrous calcium chloride, and not less than 1.6 per cent calcium stearate. All proportions are by weight.

Under test, the whitewash proved effective in reducing concrete surface temperatures by amounts of from 25 to 40 deg F. To further aid proper curing in the desert region, concrete placing was limited to the period between October 1 and June 1. Placing was permitted only against subgrade which had been thoroughly moistened to a depth of 12 in. in sandy soil, and 6 in. in other material.

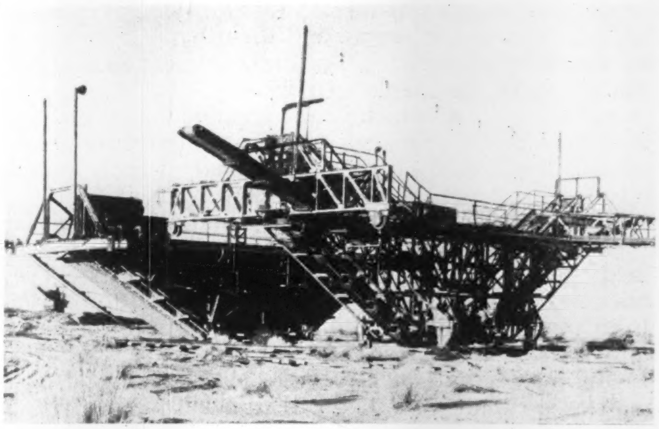


Fig. 2. Subgrade-Trimming and Monolithic Paving Machines Developed by C. W. Wood, Outside Canal Trench

The Monolithic Paver Appears in the Left Background

Training ditches and a dike on the uphill side direct storm water into channels crossing the aqueduct at siphons. In flat country, where natural water courses are not available, these training ditches and their adjacent dikes reach out several thousand feet to form a series of inverted V's, while the ditches parallel to the canal collect the water which falls within the areas enclosed by the training ditches, and discharge it at the nearest siphon crossing. Wire-reinforced rock riprap protects the canal headwalls from erosion.

Eighty-one box siphons and 12 circular siphons are used for the various short connections. To prevent damage to siphons and pumps from sand or gravel, readily cleanable traps are built into the canal bottom upstream from each pumping plant. The velocity of 4.45 ft per sec designed for the canal will keep light material moving to these traps and basins.

Twelve side-channel spillways provide a means for wasting inflows of surface water, and six radial-gate-controlled wasteways are available for the emergency release of water from sections of the canal.

GENERAL ASPECTS OF CANAL CONSTRUCTION

Bids for construction of the 62.8 miles of canal, including 33.7 miles of conduit and 14.6 miles of siphon, were called for early in October 1934. It was required that all work be completed by May 31, 1938. For the canal work 14 bids were received, and contracts were awarded to five firms.

The total contract price for the canal was $4,612,000. The estimated total cost was $9,489,000, including cement and reinforcement steel furnished by the District and also all District engineering and administration. The high, low, and average prices for the more important contract items were as given in Table I.

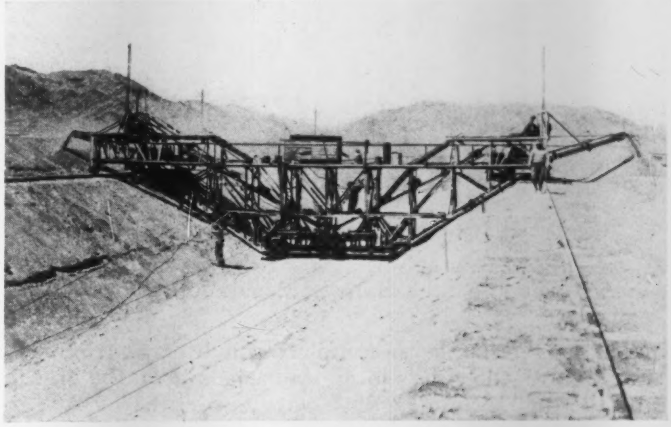


Fig. 3. Wood Subgrade-Trimming Machine in Operation

Table I. Some Unit Prices in Canal Construction Contracts

Item	High	Low	Weighted Average
Common excavation for canal, per cubic yard	$0.25	$0.16	$0.196
Concrete in canal lining, exclusive of cement furnished by District, per cubic yard	7.90	4.40	5.09
Placing reinforcing steel in canal lining, per pound	0.011	0.005	0.0066
Excavation for diagonal drains, wasteways, and borrow, per cubic yard	0.15	0.117	0.133

Bidding competition was good and the contract prices were comparatively low. For a contractor to make a profit, it was imperative that the work be well organized from the start and that every operation be mechanized as completely as practicable.

Except for the short sections in rock previously mentioned, the material encountered in canal excavation was alluvium of varying degrees of compaction and cementation. Some sections were in sandy soil, and others in a dense cemented material known locally as caliche. In some of the deeper cuts, this caliche required blasting, but along the greater part of the line the ground was particularly suitable for canal construction, being sufficiently firm to prevent raveling, yet loose enough for easy dragline work.

Except for a small amount of preliminary grading, excavation for the canal was done by draglines, varying in capacity from $1^3/_4$ cu yd with 45- to 60-ft booms, to 5 cu yd with 90-ft booms. Two of the canal contracts were awarded in combination with large amounts of conduit construction, for which several cuts were required in excess of 60 ft, one reaching 90 ft. For these deep cuts, large electrically operated machines with capacities of 4 and 5 cu yd were selected. On the other canal contracts, smaller gas- or Diesel-powered machines were used. To permit the usual progress of from 500 to 600 ft of canal lining per day, it was necessary, in average cut, to excavate about 10,000 cu yd per day.

In the normal cut-and-fill canal section, the smaller

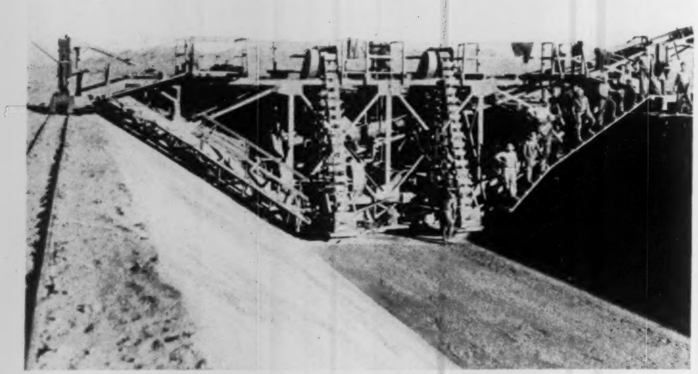


FIG. 4. GRADER OR BLADE TYPE OF SUBGRADE TRIMMER DEVELOPED BY JAHN AND BRESSI CONSTRUCTION COMPANY

machines were able to complete rough excavation with one pass of the dragline along each half of the trench, but in rolling country with varying depths of cut, rehandling was necessary, and here there was an advantage in the longer reach of the larger machine which was readily apparent. In cuts where loose material overlay indurated alluvium or rock requiring blasting, a second pass was sometimes necessary, with the dragline working in the bottom of the cut. Here again, the longer booms were a distinct advantage. On the other hand, the smaller machines were able to excavate considerably closer to neat lines—an advantage to the contractor because the specifications required that any over-excavation be refilled with selected material, compacted in not over 6-in. layers.

For continuous progress along the trench, it was found that the electrically driven draglines had practically as great freedom of movement as the others. Operating at 2,300 v, they were supplied from portable trailer-mounted substations served from a District-operated 33,000-v transmission line built along the aqueduct right of way. Finger-shaped clamps were bolted to the conductor by means of long insulated sticks, and were then used to make "hot taps" on the transmission line without interrupting other power services. With long leads of armored cable, a portable substation could serve approximately 2,000 ft of canal on each move.

Accurate final trimming of the excavation was important, since any over-excavation and resulting increased cost would have to be borne by the contractor. Under-excavation was not permitted.

After some experience with trimming by hand, all the canal contractors but one constructed special subgrade-trimming machines. These effected large reductions in labor costs and also greatly increased production.

WOOD SUBGRADE-TRIMMING MACHINE

The most comprehensive machine, and also the first to be put into use, was built on the principle of the ladder-type ditching machine, and employed two chains of side-digging buckets (Figs. 2 and 3). This was developed by C. W. Wood, of Wood and Beranda. The bucket lines and all other machinery were supported by a trussed steel frame built to the shape of the canal section and carried on 75-lb rails, laid accurately to line and grade, 2 ft back of the inside edge of each berm. The total span was 61.5 ft.

The steel frame was formed by two systems of rigidly braced trusses, one supporting the other. The primary set consisted of one 32-ft 6-in. truss, supported over each rail by 18-in. double-flanged wheels, 30 ft apart. The secondary system, which was suspended across the canal section from the primary pair, consisted of three parallel trusses, 3 ft 3 in. on centers. Auxiliary wheels were set into folding brackets at the lower corners of transverse trusses for travel outside the canal and across siphons.

Each digging line carried 14 one-cu ft toothed buckets, held rigidly in place by closely spaced rollers. These buckets, digging with one side only, worked up the slope from the center of the canal base, dumping their loads onto a short 24-in. cross-conveyor running at right angles to the bucket line. The latter belt fed a longer 24-in. conveyor, running parallel to the bucket lines, which deposited the spoil at the sides of the canal. A grader blade mounted behind each bucket line finally finished the surface to the exact section of the subgrade. Each bucket line was driven by a separate 25-hp motor and completed a circuit in 30 sec, and each conveyor was driven by a separate 10-hp motor. The machine was pulled forward by two 2-hp winches, mounted on opposite sides near the bottom part of the frame and working against $^9/_{16}$-in. cables anchored in the trench ahead. This trimming machine had a speed of from 1 to $1^1/_2$ ft per min and could complete from 30,000 to 35,000 sq ft of subgrade per shift. Complete final trimming was effected in one pass.

The trimming machines used by the Jahn and Bressi Construction Company and the Aqueduct Construction

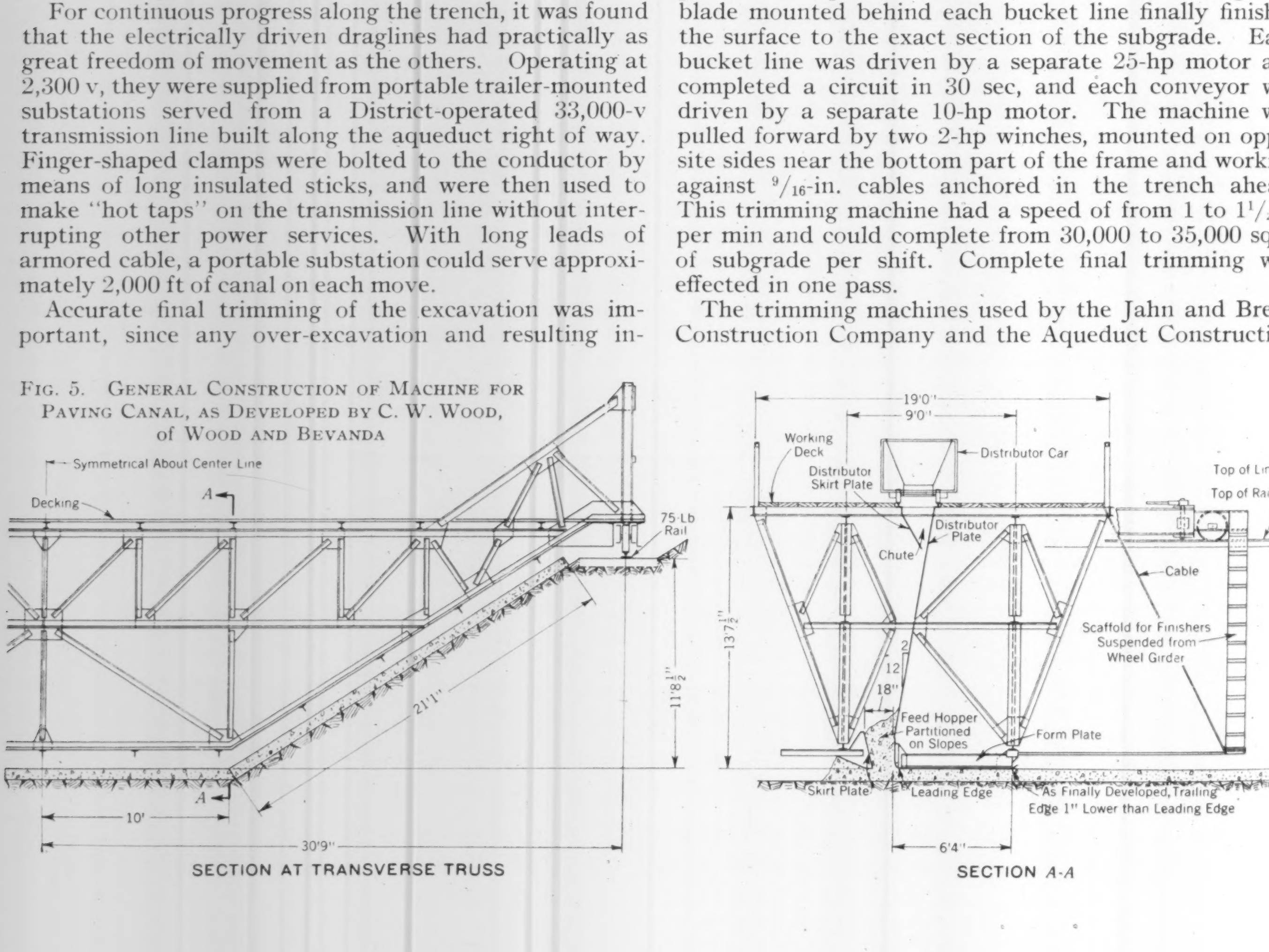


FIG. 5. GENERAL CONSTRUCTION OF MACHINE FOR PAVING CANAL, AS DEVELOPED BY C. W. WOOD, OF WOOD AND BEVANDA

SECTION AT TRANSVERSE TRUSS

SECTION A-A

Company were of the grader type (Fig. 4). The frame was similar to that of the Wood machine, but double rails on each side, set 17 in. apart and welded to steel-channel ties, constituted the operating track. The total span between the inside rails was 61.5 ft. Two main grader blades were mounted on the sloped sides of the frame. To aid in forcing spoil to the bottom, the upper end of each blade led the lower by 10 to 12 ft. A row of adjustable scarifier teeth, mounted in front of each blade, loosened indurated material and reduced the work required of the side blades. Four additional blades, mounted on the bottom of the frame in the form of a "*W*," trimmed the bottom and forced all spoil to the boots of two bucket elevators. The latter lifted the spoil onto a belt conveyor which disposed of it to waste piles on one side. Cut adjustments were made by raising or lowering the entire machine by means of hydraulic jacks mounted between the trussed frame and the wheel trucks at each corner. All power except for propulsion was supplied by a 90-hp gasoline motor, mounted on the forward end of the frame. The machine was propelled, through a rigid spread drawbar, by a caterpillar tractor working in the canal bottom. Trimming was accomplished by means of successive passes, cutting taking place only on the forward haul. Individual cuts varied from $^{1}/_{8}$ to $^{1}/_{2}$ in., depending upon the material. Imbedded rocks were removed by hand.

Although much lighter than the two described, the trimmer developed by Barrett and Hilp and Macco was also built on the grader principle. No elevator or conveyor lines were provided, the spoil being collected in the bottom of the trench by a bulldozer or scraper and removed by a dragline. The trimmer was drawn by a tractor and was adjusted by means of jacks and shims between the main frame and the railway trucks. The lightness and lack of refinement in this machine were justified by low first cost and by the fact that it was used on only one section, where 20 "portages" were required across siphon locations in eight miles.

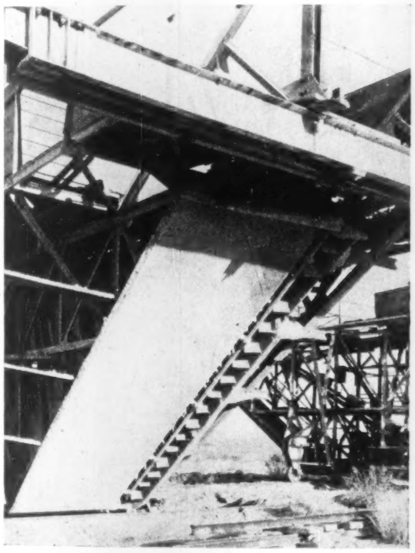


Fig. 6. Side View of Wood Paving Machine, Showing Form Plate, Feed Hopper, and Vibrator Tube

The bucket-equipped machine probably accomplished the most consistently accurate trimming, but its larger number of moving parts was a disadvantage. In rocky ground or where an excessively heavy cut was necessary, it was easily overloaded and required considerable maintenance, whereas the grader type could be readily adapted to any depth of cut and required very little maintenance. On the other hand, from 3 to 5 men were normally required to operate the bucket-type machine, compared to from 7 to 10 for the grader type. The bucket-equipped machine weighed about 40 tons and the Jahn and Bressi grader type about 30 tons. They are reported to have cost about $12,500 and $8,500, respectively. Each machine was capable of trimming, to an accuracy of $^{1}/_{8}$ in., 450 to 500 ft of canal per shift.

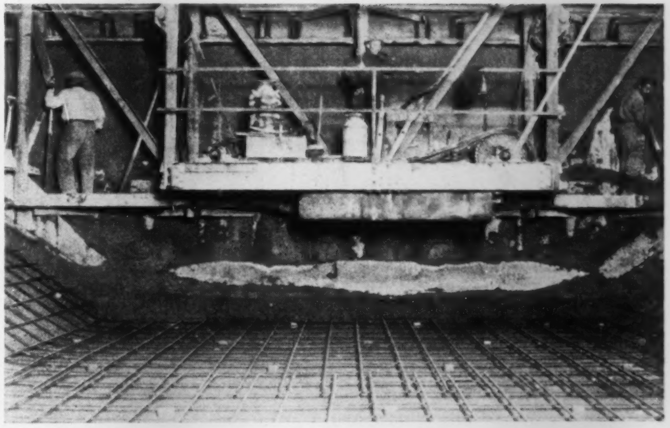


Fig. 7. Leading Edge of Jahn and Bressi Paver

With the exception of short sections poured at the beginning of construction by other means, all concrete canal lining was placed monolithically by means of a large special lining machine pioneered by C. W. Wood (Figs. 2, 5, and 6). At first, most of the contractors hesitated to make the relatively large investment involved in these machines and began placing invert concrete by highway methods well in advance of side-slope lining. The side-slope concrete was then placed, behind a narrow slip-form panel of the type developed several years ago. These methods were quickly discarded when the Wood machine was put into operation, as this made possible continuous monolithic placing and better concrete at two or three times the former rates of progress.

WOOD MACHINE FOR PAVING CANAL

In this machine, the important element was a form or screed plate, shaped exactly to the cross-section of the finished canal, fastened to the under side of a trussed frame, and provided with feed hoppers and a motorized distributor car. The trussed frame was similar to those used for the trimming machines. The machine, drawn by power winches, operated like a great trowel.

The frame was formed by two main transverse trusses, 9 ft apart, suspended from longitudinal trusses built over the rails. The lower chord of the longitudinal trusses was a box section, open at the bottom, enclosing a built-up girder under which double-flanged wheels were mounted. Jacks, working between the end trusses and the wheel girders, provided grade adjustment. A working deck 19 ft in width was built on top of the frame, with a 2-ft-gage distributor-car track midway between, and parallel to, the transverse trusses.

The form plate was of $^{1}/_{2}$-in. steel, bent upward on a smooth, short-radius curve to form a leading edge. Connected to the form plate above the leading edge, a large plate extended upward, between the transverse trusses, to a connection with the inside of the rear distributor-car rail. A distributor skirt plate, attached to the other rail and inclined towards the main distributor plate, formed a chute. From this chute the concrete slid down into a feed hopper at the bottom, formed by a continuous skirt plate attached in front of the leading edge. This feed hopper was kept full. It contained partition vanes, which prevented unconsolidated material for the slopes from sliding towards the bottom.

The machine was moved forward continuously, shaping both invert and sides as it passed. It was capable of placing lining as accurately as the grade of the tracks could be maintained. Settlement of rails occurred frequently but, by means of the adjusting jacks, correction was quickly made. One record shows a combined trimming and placing accuracy of better than 1 per cent.

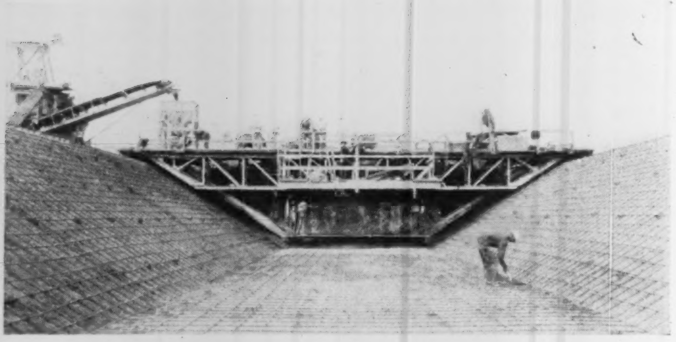


FIG. 8. UTAH CONSTRUCTION COMPANY'S PAVING MACHINE IN OPERATION

Paving machines used by the other canal contractors were modeled after the Wood machine in principle, although differences existed in framing, motive power, and mechanical operation. Figure 7 shows the leading edge of the paving machine used by the Jahn and Bressi Construction Company. The sides of the form plate on the Utah Construction Company's machine were inclined backward so that the leading edge in the bottom was 17.5 ft ahead of that at the top of the slope, as compared with 2 ft in the Wood machine. This greater inclination was more effective in preventing slope-deposited concrete from flowing towards the bottom before consolidated by the paver. Paving machines weighed from 40 to 50 tons and cost about $12,500 each.

A great deal of experimental work was done in promoting flow of concrete by the use of mechanical vibration. External vibrators, mounted on the back of the form plate, were tried by Wood and Bevanda, but were later discarded in favor of a tube, vibrating at about 2,500 rpm, located in the feeder hopper along the sides. Faster vibration tended to float the paver. Other contractors used shafts in the slope-feed hopper, rotating with a slow eccentric motion, or internal vibrators worked by hand in the feed hopper whenever the flow was poor. Utah Construction Company used a combination of external and internal hand-operated vibrators (Fig. 8).

Although some form of vibration is necessary when variations in consistency produce poor flow, it is doubtful whether any particular form of vibration should be considered an indispensable part of the pavers. It was found that better consolidation was obtained and that the tendency of the form to drag was eliminated, when the form plate was given a slight upward angle so that the leading edge was one inch higher than the trailing edge. This tilt allowed the weight of the machine to be more effective in compacting the concrete.

CONCRETE CONSTRUCTION DETAILS

Concrete with a 2,500-lb, 28-day compressive strength was secured with a cement content as low as 1.15 bbl, and averaging 1.25 bbl per cu yd.

On all contracts, concrete for lining was mixed at the point of placement in 1-yd pavers which operated from the roadway on the lower side of the canal. Batches were hauled in compartment-bodied trucks from batching plants situated at aggregate sources or railway points. These locations were seldom central and long-batch hauls were involved, the maximum being 10$^1/_2$ miles.

With concrete continuously available from two 1-cu yd paving-type mixers, a forward travel of approximately 1 ft per min was maintained, progress being limited only by the capacity of the mixers and their supply equipment.

The maximum daily progress was attained in January 1936, when Jahn and Bressi placed 944 ft of canal lining in one day, working two shifts (usually placing was done on one shift only). Also, in January 1936, the Aqueduct Construction Company placed 3,772 ft in one week, working one shift per day. The average weekly progress attained by all operators was 1,900 ft.

The pavers, of course, did not finally finish the concrete, and it was necessary to do this by hand, using wood floats followed by two steel trowelings. The finishers worked immediately behind the paving machine, standing either on runways suspended from the machine or on timber bridges built for the purpose, suspended from the paver rails (Fig. 9). Minor imperfections were corrected and some further consolidation was effected in this way. After some set had occurred, further finishing was done with steel fresno trowels. A second hand-troweling followed, at the limit of workability, to produce a hard and dense wearing surface.

One coat of sealing compound was applied between sundown and 11:00 p.m., and a second coat 4 to 6 hours later. A coat of whitewash followed within three hours after sunrise. Both the sealing compound and the whitewash were applied by pneumatic sprays from trucks equipped with compressor and tanks.

The first canal lining was completed approximately 2$^1/_2$ years ago. None of it has yet been used for the transportation of water. Cracking of the slabs has thus far been successfully controlled by the reinforcement. Canal sections through areas subject to drifting sand have passed through two full seasons without important sand accumulations, and it seems evident that the traps and settling basins provided will be ample. To further reduce the likelihood of sand accumulation, spoil banks have been oiled in regions where greatest drifting occurs.

The average total cost to the District for the completed canal sections, including all cement, steel, and engineering and administration provided by the District, is approximately $28.90 per ft, or $153,000 per mile.

All construction for the Metropolitan Water District of Southern California is under the direction of F. E. Weymouth, general manager and chief engineer. J. L. Burkholder is assistant general manager, and Julian Hinds is assistant chief engineer. Field control of the canal work was under the direction of R. C. Booth, W. E. Whittier, and John Stearns, division engineers. All those mentioned are Members of the Society.

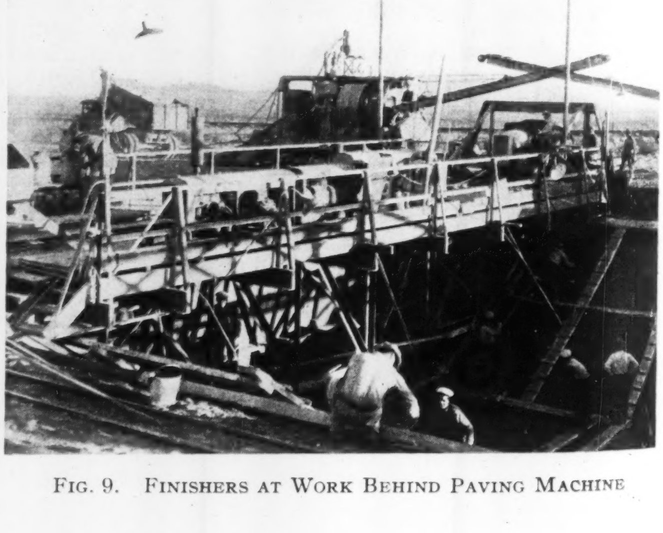


FIG. 9. FINISHERS AT WORK BEHIND PAVING MACHINE

Soil Conservation in the Texas Blacklands

A Discussion of the Means Developed for Erosion Control on a Federal Project

By H. O. Hill

Associate Member American Society of Civil Engineers
Project Leader, Soil Conservation Investigations, Blackland Experiment Station, Temple, Tex.

ENORMOUS tolls are taken from farm lands each year by water and wind erosion, whose effects are reflected not only in soil depreciation and smaller crop yields, but also in reduced reservoir capacities resulting from silting. Such losses as these are nevertheless largely preventable, says Mr. Hill, as evidenced by the successful work of the U. S. Soil Conservation Service in the Elm Creek watershed of central Texas. Among the methods of control found most effective on that project are terracing; strip cropping, both with and without terracing; pasture furrowing or ridging; and gully control by means of erosion check dams and vegetation. Many of the methods developed for use in the Texas blacklands are equally applicable to similar areas in other parts of the country. The accompanying article was developed by Mr. Hill from an address delivered by him some time ago before the Texas Section of the Society.

THE term "soil erosion" usually means only the soil wastage that has occurred largely as the result of man's thoughtless land-use practices. This kind of erosion has been increasing ever since the early colonists cut the timber and plowed the sloping virgin soils to raise cultivated crops.

RESERVOIR SILTING A SERIOUS PROBLEM

Soil that washes from fields and grazing land must eventually be deposited, and such deposits are often very detrimental. In the South many reservoirs with significant potentialities for power production have been filled with sediment in periods of from 13 to 36 years. A survey of the rate of silting of a number of reservoirs in the South and Southwest, as presented in Technical Bulletin No. 524, "Silting of Reservoirs," by Henry M. Eakin, head of hydrodynamic studies, Division of Research, Soil Conservation Service, indicates that a great many of our major reservoirs will silt up at a rate of from 0.5 to 2.4 per cent of their storage capacity per year. If this occurs, and their effective lives are cut to half their expected length, or even less, the economic result on a fully developed project is readily visualized.

Since there are physical and economic limits controlling magnitude of engineering structures such as dams, and since the problem of reservoir silting is recognized as serious, it is very appropriate that construction engineers should be seeking a solution to this problem. In the past the practice has often been the simple though uneconomical one of letting a reservoir silt up and building a new dam, or increasing the height of the old one. A comparable practice has been followed in flood control, but the raising of levees and dams cannot go on indefinitely. It therefore appears timely to consider the possibilities of controlling or alleviating floods and silting at the points where the runoff water originates.

The problems of "upstream" engineering are so complex and interrelated that engineers, agronomists, foresters, soil experts, conservationists, economists, and other scientists must cooperate to develop the proper land-use programs and control practices. These problems are being attacked by the Soil Conservation Service and allied agencies through more than 55,000 farmers on 174 projects in 45 states.

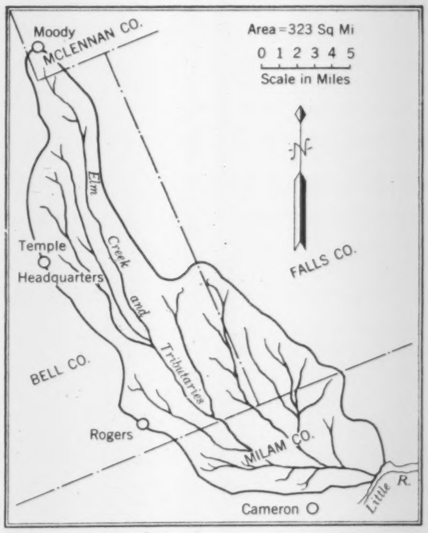


Fig. 1. The Elm Creek Project of the U. S. Soil Conservation Service
Headquarters at Temple, Tex.

Projects of the Soil Conservation Service are designed primarily to demonstrate a coordinated land-use program for conserving soil and water. The methods most commonly applied are terracing, strip cropping, contour cultivation, revegetation, contour furrowing of grazing lands, controlled grazing, and various gully-control practices. Also, the Service has instituted improved cropping systems which are often very effective in checking soil and water losses. Although the application of these methods varies widely in regions of different climate, rainfall, topography, and soils, a description of their use in one area, the Elm Creek project of the Soil Conservation Service, will serve to indicate their value.

The Elm Creek watershed (Fig. 1) is in the cotton belt of the Blacklands region of central Texas. It comprises approximately 206,000 acres of typical Blackland soils, of which 156,000 acres are included in the project. The topography varies from gently undulating to rolling. Slopes range from one-half of one to 15 per cent, averaging between 3 and 4 per cent. The area is about 90 per cent cultivated, and from 75 to 85 per cent of the total needs protection against water erosion.

Terracing is a basic erosion-control measure in such an area, where row cropping is the predominant farming system, where much of the average annual precipitation of 35 in. falls with high intensity, and where the topography, soil, and other factors make the practice desirable. A terrace is an earth embankment constructed at intervals across a slope approximately parallel to the contour lines, so as to intercept the runoff water and carry it, at a non-eroding velocity, to a suitably protected outlet. A sketch of a terraced field appears in Fig. 2. Terraces may be built level or given a slight grade toward the outlet end. Findings at the Soil and Water Conservation Experiment Station, adjacent to the Elm Creek project, indicate that variable graded terraces give better results than level terraces or those with a constant grade. Level terraces with either open or closed ends cause excessive pondage in the channel. This is due to the high colloidal content of the soil, which decreases its infiltration rate when wet. Experiments also showed greater soil loss from terraces having a constant grade than from those with a variable grade.

Variable-graded terraces on the Elm Creek watershed are level at the upper end and increase in grade as more water is collected, until they reach a maximum of 0.2 ft per 100 ft at the lower end. The grade is changed every 400 ft. The first 400 ft is level, and 0.05 ft is added to the grade per 100 ft for each additional 400-ft length of terrace. It is recommended that terraces should not be longer than 2,000 ft; longer ones are used only in special cases. The efficiency of terraces depends considerably upon their vertical spacing, which in turn is determined by rainfall, slope, cover, and soil characteristics.

Formation of Gullies Such as This Is Accelerated by Rows Running up and Down the Slope

The Upper Part of This Field Is Now Terraced and Contour-Farmed in an Effort to Save the Remaining Soil

The U. S. Department of Agriculture's Bulletin No. 1669, by C. E. Ramser, M. Am. Soc. C.E., recommends the following general spacings for terraces, which may be altered by local conditions: For a slope of 1 ft per 100 ft, a vertical interval, or drop between terraces, of 2 ft; for a slope of 2 ft, a drop of $2^1/_2$ ft; for 4 ft, 3 ft; for 6 ft, $3^1/_2$ ft; for 8 ft, 4 ft; and for 10 ft, $4^1/_2$ ft. For convenience in field location, spacings may be determined by the simple formula, $V = \frac{S + 8}{4}$, where V is the vertical interval, and S the slope of the land in feet per 100 ft.

Terraces on the Elm Creek project are built so that they will have, after settling, a minimum base width of 24 ft, a crown width of 4 ft, and a height of 18 in. This height is measured from the water channel, which should be 3 ft wide after backsloping. As a large part of the land is planted to row crops, and multiple-row machinery is commonly used for cultivating, it is desirable to build the broad-base type of terrace, so that the crops can be planted on the terrace ridges and parallel to them, without hampering cultivation.

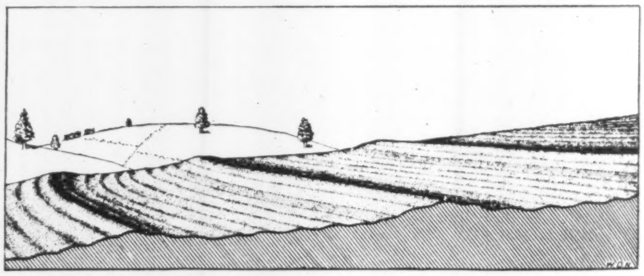
The design of terraces and of protection works for their outlets—either dams, or ditches to be covered with vegetation—requires a practical knowledge of hydraulics and construction. The rational method is used for determining runoff. The erosion check dams often used to control terrace outlets and outlet ditches have weir notches of the thin broad-crested type, for which the discharge capacity is computed by the formula, $Q = 3.39\ LH^{3/2}$, in which Q equals discharge in cubic feet per second; L, length of weir or notch in feet; and H, depth of weir notch or head on crest of weir, in feet. The formula does not consider the velocity of approach in the channel, which is on the side of safety. This and the rational method for computing runoff are discussed at length in *Brief Instructions on Methods of Gully Control,* by C. E. Ramser, M. Am. Soc. C.E., in charge of hydrologic and watershed studies, Soil Conservation Service, U. S. Department of Agriculture. Curves based on the two formulas mentioned were compiled, and are used in the design of erosion check dams in the Elm Creek watershed.

It is desirable to provide a check dam or a prepared vegetated outlet at any location where water from a terrace channel drops an appreciable distance into an outlet ditch. Structures must also be provided where a large amount of runoff water is concentrated in an outlet ditch on a steep slope. The energy of the water pouring through the weir notch is largely dissipated on the apron. The grade along the ditch, between the apron of the structure above and the spillway crest of the structure below, is from level to 0.5 per cent, depending on the type of soil. Complete protection must be provided until the runoff water is discharged into a natural drainageway of permanent character.

VEGETATION HELPFUL IN CONTROLLING TERRACE OUTLETS

In most cases, terrace outlets are controlled by vegetation or by emptying on well-sodded pastures or meadows, or into sodded outlet channels. Manning's formula is used to design outlet ditches to be protected by vegetation. The coefficient of roughness of the channel is $n = 0.03$, and the maximum design velocity for a ten-year frequency is from 5 to 8 ft per sec, depending on the quality of the vegetative cover.

Buffalo grass, *Paspalum disticum, Paspalum dilatatum* (Dallis grass), *Panicum obtusum* (wire-grass), and Bermuda grass are being used as permanent sod in outlet channels for this area. The first four can be used in almost any location, as they are easily killed by cultivation, and Bermuda grass, although more aggressive, can also be kept from spreading. The plants mentioned are perennials, and all except Dallis grass have long runners that root at the nodes to form a dense sod. The grasses are set solidly or in bands across the ditch during the winter or early spring, and are allowed to become as well established as the time and weather conditions will permit before water is discharged onto them.



Bureau of Agricultural Engineering

Fig. 2. Sketch of a Field Showing Profile After Building of Broad-Base Terraces

Vegetation in suitable locations is a very effective means of erosion control and should be utilized wherever possible. The area around the wing walls of permanent structures and the sides of permanent ditches and waterways should be planted as soon as after completion as moisture conditions will permit. It is well to point out that any system of erosion control must be carefully maintained if it is to continue to perform satisfactorily.

It is therefore recommended that no system of terraces be emptied directly into a road ditch unless provision is made for continued maintenance. Outlet ditches and structures within the farm boundary are more satisfactory because the farmer feels he is responsible for giving them careful maintenance.

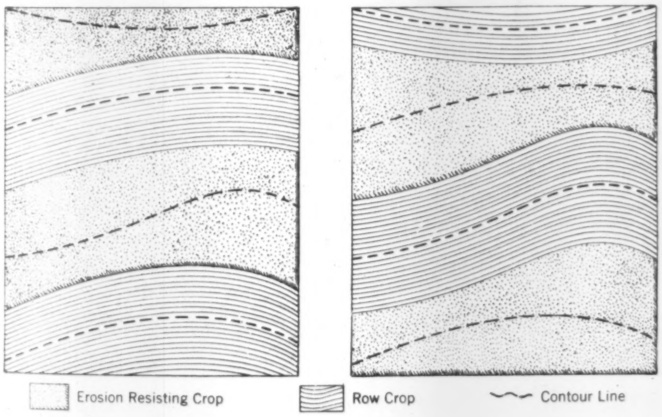
When possible, a joint ditch is laid out on the boundary between two farms, and both owners drain their terraces into it. If a farm is large, it is sometimes advisable to provide an outlet ditch near its center. In both these cases one ditch serves the purpose of two.

A short-growing type of vegetation that makes a dense cover near the ground is the most desirable for vegetated terrace outlets and outlet ditches, as it is less conducive to silting. All vegetated outlets should be grazed as a maintenance practice, but measures should be taken to prevent trail formation and tracking in wet weather. If grazing is not possible, the excess grass should probably be cut off in the early fall to allow some recovery before winter. Lack of maintenance by grazing or cutting may result in silting. Short-growing vegetation is recommended for use around structures to prevent sloughing of banks; tall dense types might reduce the capacity of the weir notch and cause the water to cut around the wing walls.

STRIP CROPPING EXCELLENT FOR EROSION CONTROL

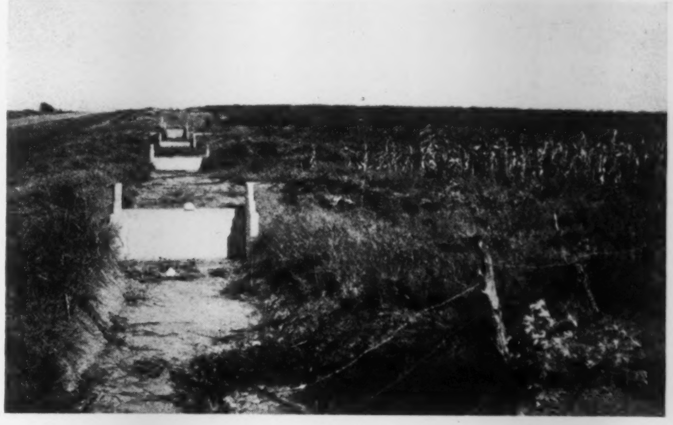
Close-growing, fibrous-rooted crops will reduce the velocity of runoff water and cause it to drop much of the soil it has collected. For this reason there has developed a practice known as "strip cropping," which consists in planting such crops in bands or strips on the contours, interspaced by row crops. This excellent erosion-control practice can be used advantageously on land that is not too steeply sloping or badly gullied. The lines for the strip crops are run level, and can be plowed out and backfurrowed so that they will not be lost during cultivation. These lines are spaced at regular intervals, the distance between them depending upon the steepness of the slope, and are used as guides in planting. The wider the strips of the erosion-resisting crops, the more effective the control. The width will usually be governed by the amount of such crops the farmer can utilize. Rotation of crops can also be accomplished in connection with strip cropping, as illustrated in Fig. 3.

Parallel stripping can be used instead of exact contour stripping if the slopes are very uniform and regular. In this system contours are run at wide intervals, and the stripping lines are laid off parallel to them at definite intervals. This practice is not generally recommended, however, as it applies only under the conditions just mentioned. Strip cropping is discussed in more detail in the U. S. Department of Agriculture's Leaflet No. 85, *Strip Cropping to Prevent Erosion*, by Dr. H. V. Geib, field representative, Division of Research, Soil Conservation Service, and in the same department's Farmers' Bulletin No. 1776, *Strip Cropping for Soil Conservation*, by W. V. Kell, associate agronomist, Soil Conservation Service.



First Year Second Year

Fig. 3. Diagram Illustrating a Simple Two-Year Strip-Cropping Rotation



A Terrace Outlet Ditch Draining Field at Right

Upper Part of Ditch Protected by Vegetation, Lower Part by Formed-Concrete Structures with Block Tops

On the Elm Creek project a strip-cropping practice has been developed in which permanent native-grass meadows are utilized as the erosion-resisting strips. These strips are planted on the contours. This practice gives year-round protection from erosion, provides a valuable hay crop, and improves the soil.

STRIP CROPPING USED IN CONJUNCTION WITH TERRACING

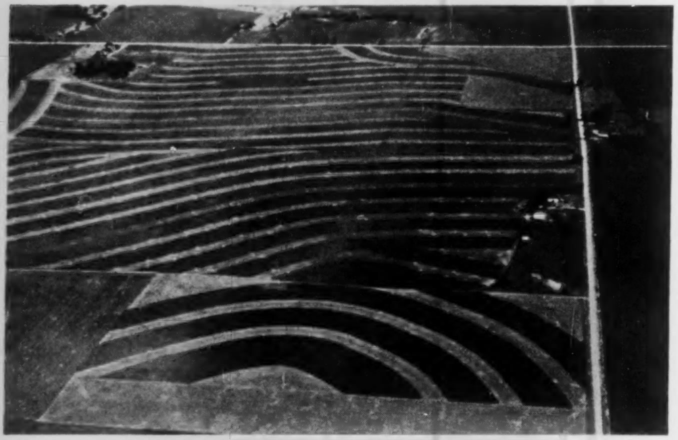
Strip cropping alone is not recommended for badly gullied fields or slopes of excessive length or steepness because it is not usually effective until the crop planted on the strip has become established. Under such conditions it should be employed only in conjunction with terracing. When so used, it presents an excellent opportunity to eliminate the principal objection to terracing, that of short, or point rows, which necessitate additional turning in tilling operations.

Several combinations of strip cropping and terracing can be used to decrease erosion, and the location of the strips in relation to the terrace ridges can be varied to effect a rotation of crops. Strip cropping can also be used as an expedient in building terraces, by planting the erosion-resisting crop in bands 30 to 40 ft wide along the terrace lines, which are run in the usual manner. This will permit construction of the terraces after the strips are harvested and while the regular farm work is slack, without injury to the crop on the rest of the field.

Any close-planted feed or grain crop can be used to resist erosion in a strip-cropping system. The sorghums, Sudan grass, oats, wheat, and Hubam clover are used on the Elm Creek watershed. Other legumes could be used if it were not for the root-rot disease which is prevalent in this area.

FURROWING OR RIDGING FOR PASTURE LAND

On this watershed there are very few good pastures, although a number of "stomp lots" have been fenced and misnamed pastures. We are taught by nature that vegetation is the most permanently effective method of conserving the soil. Therefore steep and badly eroded cultivated land is being retired from cultivation, fenced, resodded, and seeded for permanent pasturage. Base grasses of Bermuda or Buffalo are being set in furrows, plowed on the contour. These contour furrows will hold additional water and give the grass a better start. Grazing is prohibited until the grass has become well established, and then must be controlled. On this land, as on well-sodded pastures, weeds are kept down by mowing. All sloping pastures are contour-ridged, which is done by making several rounds with a turning plow or other suitable implement. These ridges are level and hold water above them, which increases grass growth and grazing capacity. Contour-listing of grazing land has also been tried rather extensively and gives indications of being a practical means of conserving water where conditions are suitable.



AIRPLANE VIEW OF A STRIP-CROPPED FIELD ON THE GARLAND, TEX., PROJECT OF THE U. S. SOIL CONSERVATION SERVICE

Corners and Irregular Spaces Where Short Point Rows Would Occur Are Planted to Oats, the Erosion-Resisting Crop Used Here

GULLY CONTROL—WHERE AND HOW

Work on large gullies is generally impractical as regards the area actually worked on, but may be justified if the gullies are eating their way into valuable farm land above. Gullies advance by drop-offs or heads, which become waterfalls in wet weather. In the control of a gully, the runoff water is diverted from the head, wherever practicable, and carried in a protected channel to a suitable discharge point which will not in turn develop into another gully. After the water has been thus diverted, a number of temporary dams of brush, stakes, hog wire, loose rock, or other available material of suitable nature can be built in the bottom of the gully. These temporary dams catch water and soil, which helps vegetation to get a start. After the dams are built, the bottom and rims of the gully are planted to grass, vines, shrubs, or trees. If the runoff cannot be diverted, the gully must be treated as a permanent waterway, that is, if it has a steep grade, practically the same as a terrace outlet ditch. If there is very little grade, it is sometimes advisable to build a soil-saving dam across the gully and provide a drop-inlet culvert to take care of the water. With this treatment the rim of the gully would be planted, as well as the silt-fill above the dam as the deltas form.

Forest plantings and reforestation are not used as much on the Elm Creek watershed as on other projects, as grass generally appears more economical there. Under certain conditions, however, such plantings may be the best treatment for badly gullied and eroded areas, as well as for other areas that cannot be profitably cultivated.

STUDIES INITIATED TO SUPPLY NEEDED DATA

In any work as new as soil-erosion control, there is always need for much information that is not available. Because of this, a number of special studies have been started on the Elm Creek watershed. Little is known about various grass or vegetative coverings when used as a protection for permanent waterways or outlet channels. Studies are being made to determine some maximum velocities of water flow that can be used in the design of sodded outlet ditches. A large number of terrace outlets and outlet channels have been prepared with several kinds and densities of vegetative covering in which varying velocities will occur. The maximum depth of water in these channels is recorded on staff gages, the maximum velocity computed, and the location and degree of erosion or silting noted. Limited observations to date indicate that a minimum as well as a maximum velocity must be considered in order to eliminate silting as well as erosion. The optimum velocities under the limited conditions and cases of observation were from 4 to 6 ft per sec.

A PASTURE RECENTLY CONTOUR-LISTED

Furrows Conserve Moisture for Growth of Grass

Studies are also being made of the effectiveness and comparative cost of different types of terrace outlet structures and erosion check dams. Structures have been built of formed concrete, concrete blocks, rock masonry, concrete-filled bags, combinations of concrete blocks and concrete placed without form-work, and concrete alone placed without form-work except where the parts of the structure rise above solid earth. There is very little significant difference between the design or effectiveness of these different types except in materials and method of construction. Rock masonry, concrete without form-work, and the combination concrete block and concrete without form-work have proved the most economical. Rock masonry is economical only where native rock of suitable quality is available. Because of the limited local supply of durable stone, this material is very little used in the Blackland area.

All this conservation work is being done with the thought that such a program must be complete, practical, and permanently effective. It is not a task for one man or one group; it must be accomplished through cooperation between individuals, communities, cities, counties, states, and the national government. It has been truthfully said that "the wealth of a nation lies close to the soil."

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Length of Suspended Cable Under Any System of Vertical Loads

By JEFFREY B. MACPHAIL, ASSOC. M. AM. SOC. C.E.

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THERE is no difficulty in principle in calculating the length of a cable hanging freely between two points and carrying any system of concentrated and uniformly distributed loads, but the arithmetical labor is so great that a simplification of the usual method seems to be worth presentation, particularly for use when many repetitions are needed—as in the calculation of sags in cableways and outdoor switching stations under varying conditions of temperature and sleet or other loads.

Consider the cable shown in Fig. 1 (*a*). It is taken on a horizontal span for the present, leaving the question of the inclined span for consideration in a later paragraph. Making the usual simplifying assumption that uniform loads are constant along horizontal lines, the vertical reactions at the supports can be calculated by statics as for a simple beam.

Taking moments about any point on the cable, a state of equilibrium is expressed by the equation, $Hy = M$, where H is the constant horizontal component of the cable tension and M is the moment of the reaction and all loads to the left of the point; or $y = M/H$. If any two of these quantities are known from the conditions of the problem or the choice of the designer, the third can then be calculated. Hence the cable takes the shape of a number of parabolic arcs, four in the case shown, whose parameters alter at each change in the load diagram. Putting $z = dy/dx$, the length of the cable is the length of the four arcs, or

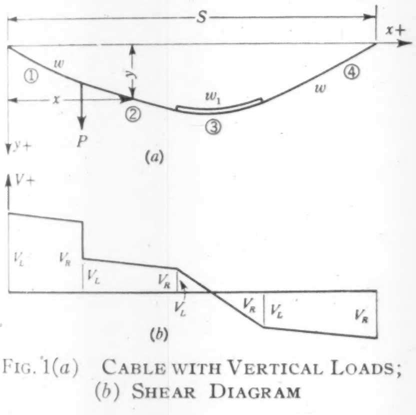

FIG. 1(*a*) CABLE WITH VERTICAL LOADS; (*b*) SHEAR DIAGRAM

$$l = \Sigma \int \sqrt{1 + z^2} \quad dx$$

After substituting for z in terms of x, this can be integrated directly, but the result is too complicated for practical use. It may be remarked that if any zone contains a distributed load which varies linearly instead of being uniform, z^2 will be a quartic function of x and the integral will lead to elliptic functions.

An easier way is to expand the radical into an infinite series, so that

$$l = \Sigma \int \left(1 + \frac{z^2}{2} - \frac{z^4}{8} + \dots\dots\dots\dots \right) dx$$

It is only necessary to begin the next step of substitution, squaring, and integration, to see that the arithmetic is very laborious even when only two terms in the series are retained. Inspection then suggests that we use the series directly in its present simple form by changing variables. It will be found that $dx = -H\,dz/w$, where w is the weight of cable and load per unit length in the part considered. After substitution and integration,

$$l = -\Sigma \frac{H}{w} \left(z + \frac{z^3}{6} - \frac{z^5}{40} + \dots\dots\dots \right)_{z_L}^{z_R}$$

and w is kept under the summation sign as a reminder that it may differ in various parts of the cable. Because the cable curve is a moment curve, $H\,dy/dx = dM/dx = V$, the shear at any point (Fig. 1*b*). Hence $z = V/H$, so the limits of integration are easy. Introducing limits, the first term in the summation becomes merely the horizontal length of the zone, s, and we have finally, if V_L and V_R are the shears at the left and right of any zone:

$$l = s - \frac{1}{6H^2} \Sigma \frac{V_R^3 - V_L^3}{w} + \frac{1}{40H^4} \Sigma \frac{V_R^5 - V_L^5}{w} .$$

Some remarks on this formula will be helpful. V is taken positive at the left-hand end of the cable, so the final sign of the second term is positive, and of the third, negative. The infinite series used is convergent only for $z < 1$ but this almost always happens because H appears in the denominator of $z = V/H$. The calculation of the terms $(V_R^3 - V_L^3)$ can be done almost mechanically in tabular form. In the first column, start at the top with the left reaction; subtract successively the loads and get the successive shears. Their cubes are tabulated in the second column directly from a table of cubes, and the differences are entered in the third column. Dividing these differences by the appropriate values of w gives the fourth column, and vertical addition gives the sum needed in calculating the second term in the length. Care should be taken with the algebraic signs; in the first column the upper terms will be positive and the lower ones generally negative, and signs in the succeeding columns will be affected accordingly. The accuracy which is obtained without trouble will be greater than is ever normally required. The third term of the formula can be calculated by slide-rule in two more columns, and it can be included if it makes any difference in the number of significant figures being used.

Finally, if the span is inclined, with the right-hand end at a distance h below the other, the procedure is exactly the same if care be taken to include a term Hh/s in the reaction at the left support and one of opposite sign at the lower support.

Deflections at any point are given by dividing H into the area of the shear diagram up to that point.

Appraisal of Unit-Graph Method of Flood Estimation

By C. R. PETTIS, M. AM. SOC. C.E.

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CONSIDERABLE study has been made of the unit graph and distribution graph as a method for determining certain facts concerning the flood characteristics of rivers; but so far as I can learn no critical analysis has been made of the method with a view to determining its accuracy, advantages, and limitations.

A unit graph is a hydrograph of a single flood on a particular river, with the discharge, which may be in cubic feet per second, plotted as ordinates, to a horizontal scale that represents time intervals. The distribution graph may be considered as a composite of several unit graphs for the same station; it should be more accurate than the individual unit graphs of which it is composed. The same principle underlies the unit graph and the distribution graph.

The principal value of the unit-graph method is that by it a study can be made of the characteristics of observed small floods, and from this study certain deductions can be made concerning the larger floods upon which engineering design must be based. One critical point in most engineering design is the maximum discharge, in cubic feet per second, which will accompany an assumed maximum runoff. This maximum discharge can be determined from the maximum ordinate of any unit graph, using the fundamental assumption that the ordinates for any runoffs will vary directly as the intensity of the net rainfall (total storm runoff).

From the fundamental assumption and by simple proportion, it is possible to determine from any unit graph or distribution graph, the maximum discharge in cubic feet per second that is indicated for a total runoff of one inch depth over the drainage area. This unit crest discharge will be designated by the letter g. According to the fundamental hypothesis, all unit graphs for a given river station should give the same value of g. If they do not, the variations must be caused by observational errors, unless there is an error in the fundamental hypothesis.

U. S. Geological Survey Water Supply Paper 772, page 133, gives a study of unit hydrographs and distribution graphs of eight rivers. In the present analysis only seven of these rivers will be considered. (The eighth river, the Red, is partly in a humid region and partly in a semi-arid region; the assumption of a uniform runoff from the entire area is therefore not in accord with fact, and hence the Red River is not comparable with the others.) For the seven rivers considered, there are 56 unit hydrographs; the runoff of the different hydrographs varies from 0.05 to 2.01 in. and averages slightly less than 0.4 in. If these unit graphs or distribution graphs are to be of value for flood design, it will be necessary to extrapolate to at least 6-in. runoffs, which means that the various ordinates will be multiplied by factors which will average 15—a wide extrapolation, which calls for caution but does not necessarily disbar the method.

In Fig. 1 the values of unit crest discharges, g, are plotted against the corresponding runoffs, and lines are drawn joining the points for each river. If the fundamental assumption were true throughout the entire range, and there were no observational errors, each of these lines would be straight and vertical.

The chart indicates definitely that individual unit graphs of less than $^1/_2$-in. runoff are not reliable. On the other hand, although the evidence is not entirely conclusive, it is believed that a consideration of the chart, in connection with the analysis which follows, justifies the following statements: The fundamental assumption of the unit-graph method is correct for all practical purposes; the seven distribution graphs will all be of value in a study of the respective rivers, and most of them will be fairly accurate.

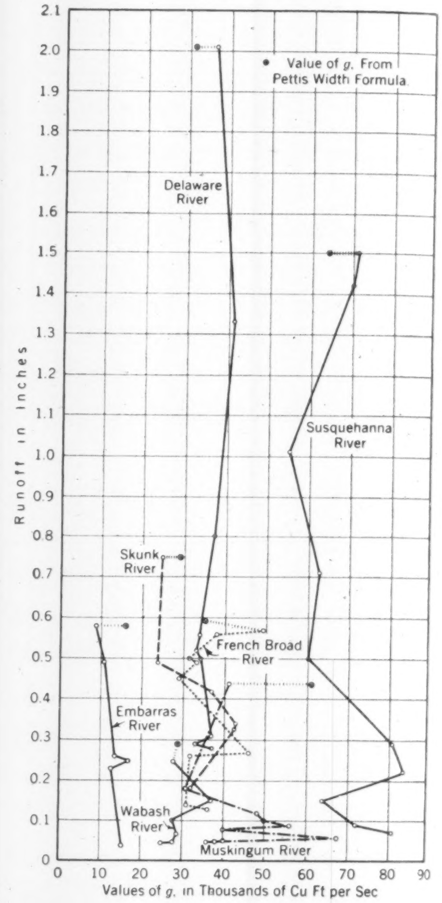

FIG. 1. VALUE OF g FOR VARIOUS RUNOFFS, FOR SEVEN RIVERS, COMPUTED FROM UNIT HYDROGRAPHS

The value of g for any river can be determined by means of the "width formula" (which I presented in *Engineering News Record* for June 21, 1934). The values of g as thus determined can be checked against the values as determined from unit hydrographs or distribution graphs.

In the *Journal of the Boston Society of Civil Engineers* for September 1930, page 399, is found the following statement: "A rare flood runoff, R, of 6 in. within the concentration period is to be expected for all drainage areas of from 10 sq miles to 10,000 sq miles in New England. The frequency of such floods is probably somewhere between 50 and 200 years." A considerable study of flood probabilities indicates that the preceding statement might be modified to read, "For New England, the probable 100-year flood corresponds to a runoff of 6 in." This statement is entirely consistent with the width formula, although the width formula is based on a rainfall index, and unit hydrographs consider only the runoff. It will be assumed that all rivers considered in the following comparisons have 100-year floods corresponding to 6-in. runoffs, since they are all in practically the same rainfall belt.

By the width formula, the flood corresponding to a 6-in. runoff is given by $Q = 310\ (PW)^{1.25}$, in which Q is the maximum discharge in cubic feet per second; P is a rainfall index, which in these cases will be approximately 6; and W is the average width of the drainage basin in miles. (The numerical coefficient, 310, applies generally throughout New England.) If $P = 6$, then $Q = 2{,}911\ W^{1.25}$; and since this corresponds to a 6-in. runoff, $g = Q/6 = 485\ W^{1.25}$.

The report of the Boston Society contains a number of hydrographs, of which eight have been selected, for rivers which do not have too large a portion of their flow controlled by lakes, and which seem to comply with the requirements for a unit graph sufficiently well to be used for purposes of comparison.

Table I (*a*) shows a comparison of the unit crest discharges of these eight rivers, as determined by the width formula, with the unit crest discharges from the unit hydrographs. The rivers are arranged in descending order of magnitude of the runoffs. The average width, *W*, of each river basin is shown. Where *W* is followed by a plus sign, the area is pear-shaped, with the wider portion near the gaging station, and 15 per cent has been added to the value of *g*; this is a fair rule of thumb when the area is not unusual, but appears pear-shaped upon inspection.

Table I (*b*) shows a comparison of the unit crest discharges of the seven rivers from U.S.G.S. Water Supply Paper 772, as determined by the width formula, and as determined for each river by taking the average value of *g* as scaled from the individual unit hydrographs. The rivers are shown in the order of the maximum runoff that was considered for each river. The basin of the Skunk River is of an unusual shape, and *W* has been figured from only the lower wide portion of the river which is within 70 miles of Augusta by water.

No effort has been made to make the adjustments which would naturally result from a more detailed study of the individual rivers, yet the check in the values of *g* obtained by the two different methods is surprisingly close for all rivers shown except the Muskingum. The base flow, or underground flow, which is subtracted from the total flow to obtain the runoff, is comparatively small for the New England rivers; it is relatively much larger for some of the other rivers with smaller runoffs. The amount of base flow contained in the Muskingum hydrographs is indicated by the fact that the value of *g* as figured for the Muskingum, with no deduction for base flow, is 67.

In using unit hydrographs in the manner indicated, care should be taken that the runoff used is practically confined to precipitation which fell in a period of time no greater than the concentration period of the individual river. For concentration period see "Relation of Rainfall to Flood Runoff," *The Military Engineer*, March–April 1936.

Table I. Comparison of Unit Crest Discharges, *g*, by Width Formula and by Unit Hydrographs

River	Station	Runoff, in Inches	*W*, in Miles	*g*, in Units of 1,000 Cu Ft per Sec: Width Formula	*g*, in Units of 1,000 Cu Ft per Sec: Hydrograph
		(a) New England Rivers			
Westfield.	Westfield	4.3	12	11	10
Pemigewassett . .	Plymouth	4.0	17	17	15
Connecticut . . .	W. River Jct.	3.9	27*	35	36
Deerfield	Charlemont	3.8	9*	9	9
Connecticut . . .	Vernon	3.5	29*	38	42
Connecticut . . .	Sunderland	3.4	33*	44	45
Connecticut . . .	South Newbury	3.3	23	25	23
Merrimack	Lowell	2.2	29	33	32
		(b) Other Rivers			
Delaware	Pt. Jervis	2.0	25*	31	36
Susquehanna . . .	Towanda	1.5	44*	64	70
Skunk	Augusta	0.75	26†	29	34
Embarrass	Ste. Marie	0.58	16	16	13
French Broad. . .	Dandridge	0.57	31	35	35
Muskingum . . .	Dresden	0.44	48	61	45
Wabash	Logansport	0.25	26	29	29

* Pear-shaped areas; *g* increased by 15 per cent.

† Figured for area within 70 miles of Augusta, by water.

The following conclusions seem to be justified by the preceding comparison:

1. The fundamental assumption of the unit-graph method is correct, for all practical purposes.
2. An individual unit hydrograph of less than $^1/_2$-in. runoff is not reliable; in general, the reliability of unit hydrographs increases with the amount of runoff.
3. A distribution graph prepared from several unit hydrographs, even with small runoffs, will generally be fairly reliable.
4. The main source of error in unit hydrographs is in the estimate of base flow; this is especially true for small runoffs.
5. If the width formula is used as a check, the main source of error will be in the adjustment for pear-shaped areas; in practically every case the adjustment will increase the value of *g*.

Variable Multiple-Weir Canal Drop

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In designing the supply canal and power plants for the Central Nebraska Public Power and Irrigation District (Tri-County Project), it was found necessary to provide drops into two of the regulating reservoirs which would safely handle a flow of 1,800 to 2,000 cu ft per sec throughout a wide range of tailwater levels. The ordinary chute type of drop with a stilling basin at its terminus, such as is used for canal drops, would not serve the purpose, as the stilling basin would be submerged at high reservoir or tailwater levels and would function properly only at the lowest stages. This point is sometimes overlooked in designing variable-fall drops, but to do so leads to trouble, as the excessively turbulent tailwater is certain to cut around and undermine the narrow chute whenever the lower stilling pool is submerged.

At the Jeffrey Power House the flow will be 2,000 cu ft per sec dropping through a maximum fall of 15 ft, and at the Johnson Power House there will be a flow of 1,800 cu ft per sec with a drop of from 6 ft to 32.8 ft. A drop structure following conventional lines was first designed and a 1:24 model was built and tested. The test proved that such a structure would have to be much larger and more elaborate than was at first contemplated. It appeared that a stilling pool 200 ft long, 100 ft wide, 20 ft deep would be required, and in addition a great deal of masonry and riprap would be necessary to insure the safety of the structure at the higher stages of tailwater.

In Civil Engineering for November 1934, W. R. Barrows, Jun. Am. Soc. C.E., and A. W. Newcomer, Assoc. M. Am. Soc. C.E., described model studies for a multiple-weir drop designed to carry 400 cu ft per sec down an 86-ft drop. This was a fixed drop with constant

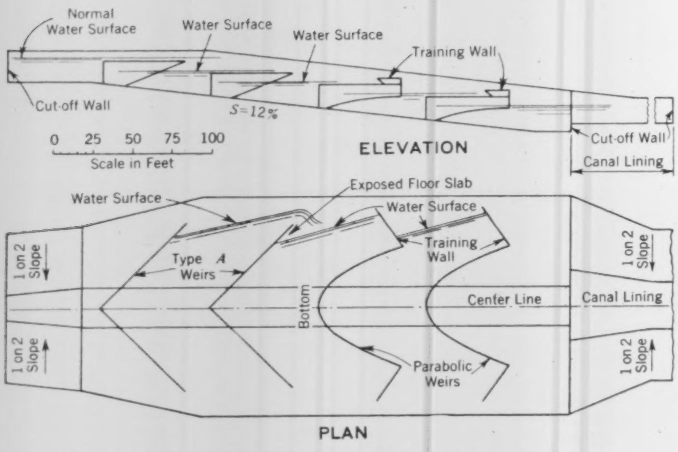

FIG. 1. MULTIPLE-WEIR CANAL DROP, SHOWING TWO TYPES OF WEIR

head and tailwater levels; moreover, the location precluded any possibility of having to take care of ice floes. Nevertheless, the general design seemed to fit the needs of the Jeffrey and Johnson drops to perfection, inasmuch as the behavior of the drop was entirely independent of tailwater elevations; so it was used as a basis for the preliminary design of our second model. The Barrows-Newcomer study supplied the necessary data for selecting the proper cross-section for the main chute, the floor slope, proportions and angles of the weir structures, and especially the number and spacing of the weirs, which latter features are governed by the depth of water required below each weir.

In Fig. 1 is shown an outline of the structure. From this outline a wooden model was made on a scale of 1:32. The "Type A" weirs were proportioned from information taken from Mr. Barrow's article, and in the first test all weirs were of this type. The model was entirely successful in handling the required quantity of water without excessive turbulence; it is noteworthy that even the most severe induced surges in the pool above the first weir were entirely obliterated before the impulses had reached the third pool. The only weakness in the design from our point of view was the fact that it permitted water to fall directly on the exposed floor slab at the outer ends of the weirs.

This is ordinarily not a serious objection providing the slab is designed to withstand the shock, but in the present case there was a strong possibility that ice floes might do severe damage to this exposed floor. In order to correct this fault a water cushion was provided for the entire length of the weirs by deflecting them inward at the ends and installing flanking or baffle walls at each side to prevent water flowing past. As there is a tendency for the water to pile up against these baffle walls, the angle they make with the axis of the main structure must be selected carefully.

Experimentation with the shape of the weirs soon led to the conclusion that a curved weir would best serve the requirements. The shape finally adopted was a true parabola having its principal chord at approximately the lower end of the V-shaped or "Type A" weirs and its apex at the apex of the "Type A" weirs. The total length of weir along this parabola is slightly less than that for the "Type A" weirs. The minimum pool depth below the water jet is the equivalent of $4^1/_2$ ft in the prototype. With the parabolic weir, the flow was far more uniform than with the V-type, and the cushioning effect for ice floes passing down the drop was immeasurably greater. It is also apparent that the parabolic weirs can be designed as arch dams and so afford worthwhile savings in concrete and reinforcement as compared to "Type A" structures, which must be designed as cantilevers.

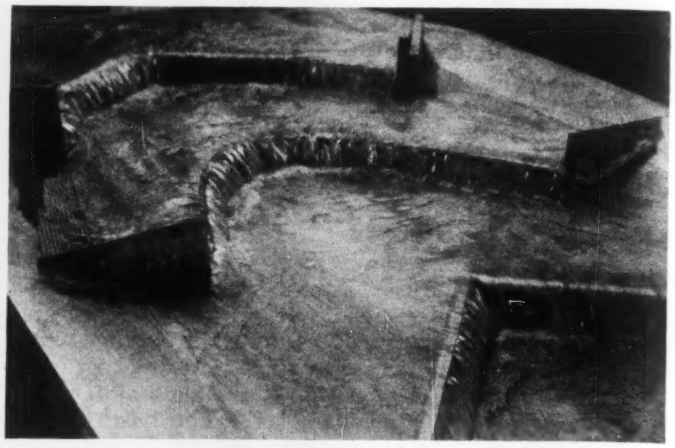

FIG. 2. FLOW OVER "TYPE A" WEIRS (TOP AND BOTTOM) AND PARABOLIC WEIR (CENTER)
Note Training Walls

Small drainage openings will be provided in each weir at the floor level to permit any entrained silt to pass through. However, it is not believed that there is much possibility of silt remaining in the structure, as it was impossible to keep anything finer than coarse sand in the model, even when no drainage openings were provided.

Limits of Shadow Determined Graphically

By R. S. SWINTON, M. AM. SOC. C.E.

ASSOCIATE PROFESSOR OF ENGINEERING MECHANICS, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICH.

THE area of shadow on a street surface or building wall is a function of the direction of the street or wall, the season of the year, the latitude, the distance between buildings, and the height of buildings. Determination of such areas is important in studying the setback of buildings and the orientation and fenestration of hospitals, factories, and private residences on estates. A graphical method is here described by which the "hours of sunlight," accurate to within two or three minutes, can be obtained for any time in the year for any given location.

The problem is to find the altitude and azimuth of the sun at any given time. This is the direction of a ray of sunlight, and if the ray is passed tangent to the coping of a roof, it gives the corresponding limit of shadow. Six or eight solutions for one day of each month provide data from which curves can be drawn showing the "hours of sunlight" per sunny day throughout the year. The steps in the solution are as follows:

1. Draw two circles (Fig. 1) of about 5-in. radius, and through the one to the left draw horizontal and vertical axes. This circle represents the celestial sphere, the

dot O at the center being the earth. Protruding from the right and left of the earth are the two poles intersecting the celestial sphere at N and S. The vertical line through O represents the plane of the equator in profile. The right-hand circle is the intersection of the equator with the celestial sphere and its center is the N pole.

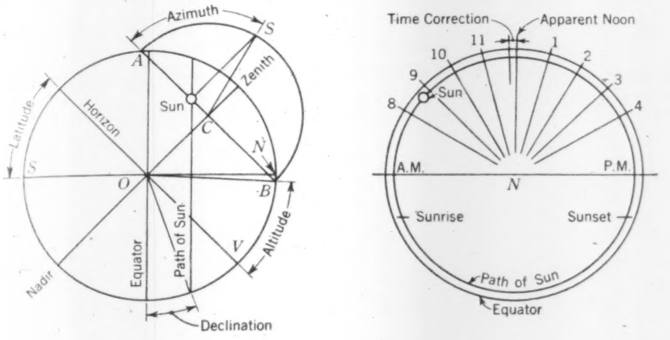

FIG. 1. GRAPHICAL SOLUTION, STEPS 1 TO 7

2. From the equator lay off the angle of declination for the day in question (it is assumed to be constant for the day) and draw the "path of the sun" parallel to the equator. In the right-hand circle draw the path of the sun concentric to the great circle, determining its radius by projection.

3. From the S pole lay off the latitude, and draw the profile of the horizon plane. This will intersect the path of the sun at sunrise and sunset, and the intersection can be projected across to the right-hand figure. Also draw the zenith line, through O, perpendicular to the horizon.

4. On a thin sheet of paper lay off 24 equal angles of 15 deg or one hour each. Center this on N of the right-hand circle and revolve it through the time-correction angle given in the almanac. (A further check is obtained by noting the time of sunrise and sunset as already plotted and comparing with the local almanac. Errors should not exceed one minute of time.) The position of the sun at any hour of the day can then be plotted in the right-hand circle. The position shown in Fig. 1 is for 8:40 a.m.

5. Locate the sun in the left-hand circle by projection.

6. Through "sun," draw a line AB parallel to the horizon, intersecting the zenith line at C. The angle VOB is the desired altitude of the sun.

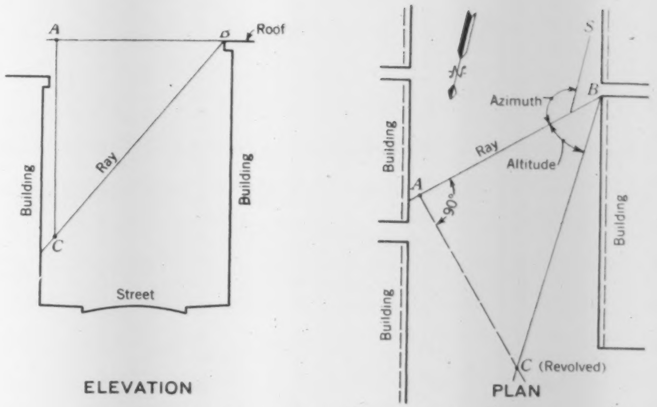

FIG. 2. GRAPHICAL SOLUTION, STEP 8

7. With C as center, draw the semicircle ASC; and project "sun," perpendicular to AB, onto the semicircle at S. Angle ACS (or $360°\text{-}ACS$) is the azimuth of the sun. If south is zero, and the circle is read clockwise, the smaller readings are afternoon observations.

In explanation of Steps 6 and 7, it may be pointed out that AB is the trace of a circle intersecting the celestial sphere. More specifically, it is the base of a cone described by the line of sight of a transit first pointed at the sun and then spun on its vertical axis. ASB is half of this circle, rotated through 90 deg into the plane of the paper.

8. Now that the azimuth and altitude of the sun, or of a ray of light, are known, the ray may be passed tangent to the edge of a roof, and the intersection of the ray with the ground or adjacent building gives the limit of sunlight for the desired time. In this connection see Fig. 2. In the plan view lay off AB, the direction of the ray, on the azimuth found in Step 7. (Point B is a limiting ledge on the roof.) From AB lay off at B the altitude angle ABC (= angle VOB of Step 6); and at a convenient point, A, erect a perpendicular intersecting BC at C. On the elevation, locate the vertical projection of Point A and measure downward the distance AC. Draw BC to its intersection with the building wall or the pavement.

Incidentally, there are many other practical applications of the diagrams described here. With an understanding of this process one can readily solve, or derive formulas for, any two missing items in the list—time, altitude, azimuth, latitude, and declination.

Solving Quadratics by Slide Rule

By JOSEPH BARNETT, M. AM. SOC. C.E.

SENIOR HIGHWAY DESIGN ENGINEER, U. S.
BUREAU OF PUBLIC ROADS,
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THE following method of solving a quadratic equation by slide rule is a handy shortcut (not original with the author) that may not be generally known.

All quadratic equations can be brought to the form, $x^2 \pm k_1 x \pm k_2 = 0$, by simple division. The equation can be written $(x \pm a)(x \pm b) = 0$. It is required to find a and b; $k_2 = ab$ and $k_1 = a \pm b$, which permits solution on any slide rule by placing the slide over k_2 on the D-scale and adjusting the C-scale until the sum of (or the difference between) the figure on the C-scale under the slide and the figure on D-scale under the index of the C-scale equals k_1. Few trials are required—and an engineer should be able to add (or subtract) two figures mentally.

For example, solve the equation $x^2 + 7.8x + 13.76 = 0$. Place the slide over 13.76 on the D-scale. Move the C-scale until the figure on the D-scale under the index of the C-scale is 5.1, and the figure on the C-scale under the slide is 2.7. Any other location of the movable scale results in a sum other than 7.8. The product must be 13.76 because of the position of the slide.

In the matter of signs there are but four possible combinations, as follows:

(1) $x^2 + k_1x + k_2 = 0$ represents $(x + a)(x + b) = 0$; $k_1 = a + b$

(2) $x^2 + k_1x - k_2 = 0$ represents $(x + a)(x - b) = 0$; $k_1 = a - b$

(3) $x^2 - k_1x - k_2 = 0$ represents $(x + a)(x - b) = 0$; $k_1 = b - a$

(4) $x^2 - k_1x + k_2 = 0$ represents $(x - a)(x - b) = 0$; $k_1 = a + b$

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Economic Considerations in Building Express Highways

To the Editor: Highway engineers are deeply indebted to John S. Crandell, M. Am. Soc. C.E., for his article on "The Express Road and the Highway System" in the October issue.

To determine what express highways are justifiable and their design, construction, and operation, we must consider the social, economic, and political factors involved. Also, the engineer must form final conclusions upon which the state will act.

It is a fundamental principle that the recommendations of the engineer should be predicated upon justification—that is, the economic benefits directly resulting from an expenditure. However, in addition to this, justification may also depend upon such factors as military considerations, convenience, and safety.

As a rule, engineers and others in arriving at conclusions first inquire if the direct economic benefits warrant the cost, as would be the procedure in ordinary business transactions. No business man will spend his funds unless he anticipates a sufficient revenue to meet the costs of operation, taxes, and depreciation and to yield him a return of 4, 5, or 6 per cent on his investment.

Judgment as to military justification is very difficult, as it is almost entirely a question of opinion. Justification on grounds of convenience, safety, and other items of a purely public-welfare character, are equally without any definite yardstick of measurement. To assist in forming judgments in these matters it is common practice to set a price on some unit, such as time or distance, thus determining the annual saving or indirect benefit.

An example of this is found in the fact that persons interested in motor-vehicle traffic safety place monetary values upon the lives of human beings. Estimates have been made for justification of the construction of the St. Lawrence waterway, and these estimates of saving in the cost of shipping or through the reduction in freight rates are extremely speculative. Another example of such justification is found in estimates for the proposed bridge across the straits connecting Lake Huron and Lake Michigan, in which the saving of time of every traveler who crosses the straits has been reduced to a money value. It is true that the elimination of delay is probably of value to the commercial vehicle and to an employer who is paying his employees on an hourly basis, but such reasoning seems fallacious when applied to the occupants of pleasure vehicles. It is to be regretted that engineers as well as others frequently form judgments by this type of metaphysical reasoning.

In building express highways, two factors are usually considered. It is frequently claimed that these highways should be regarded as important factors in reducing highway accidents—death, personal injury, and property damage. The other factor considered is that of convenience. Certainly the two should not be lumped together without a careful evaluation of each to determine whether the total benefits obtained are sufficient justification for the expenditure.

Much is heard about the safety of elevated highways. One of our large metropolitan papers has regularly admonished its readers that, "More than 98 per cent of the city's automobile fatalities are of a nature physically impossible on an elevated highway." From this the average reader might reasonably presume that, with the building of an elevated highway for this metropolis (the mileage of which would be a very small fraction of 1 per cent of the total mileage of the city), 98 per cent of all traffic accidents would at once disappear. Our studies on this subject at the University of Michigan lead us to conclude that the reduction in deaths, personal injuries, and property damage resulting from the construction of the proposed elevated highway would be too small to be detected.

Evaluating convenience is an extremely difficult task. Our studies at the University of Michigan have led us to conclude that, in many instances, the convenience obtained produced but little economic return.

Engineers in making estimates of revenue from tolls or other sources and annual expenditures should be careful to obtain the highest degree of accuracy. Where the economic returns are not sufficient to warrant justification, and military needs, safety, or other elements are evaluated in terms of money, great caution must be exercised both in estimating the number of units and the unit price adopted.

John S. Worley, M. Am. Soc. C.E.
Professor of Transportation, University of Michigan

Ann Arbor, Mich.
December 26, 1937

Licensing Tourist Camps

To the Editor: In his article on "Tourist Camp and Roadside Sanitation," in the October issue, Edward D. Rich, M. Am. Soc. C.E., advances the opinion that roadside and resort surveys are undoubtedly of great value in promoting general health because of the education of the public in health conservation. However, he also points out the fact that such work probably does not accomplish astonishing results in the prevention of actual sickness and death. I am prepared to agree that the health educational value of a resort control program probably accomplishes the most far-reaching results. But the actual number of cases of sickness that may be prevented is perhaps greater than most of us realize. With our present means of reporting disease it is impossible to definitely trace all communicable diseases which originate in a tourist group. It is a known fact that the typhoid rate is greater during vacation season.

The disastrous Winona Lake, Ind., typhoid epidemic of 1925 originated with transients, as did Chicago's outbreak of amoebic dysentery in 1933 and the circus typhoid epidemic of 1934. While the latter illustrations are not exactly applicable to the type of establishment under discussion here, they must be classed as epidemics among transients and should therefore sound a warning. The Winona Lake epidemic was caused by a cross-connection with a contaminated water supply. At the present time part of the grounds at Winona Lake contain a licensed tourist camp. Another meeting of the same organization present at the time of the typhoid outbreak was held in Winona Lake last year with no known typhoid or other communicable disease. Had Indiana been licensing tourist camps in 1925, the fatal cross-connection might have been revealed and the epidemic prevented.

It is also my opinion that the licensing of tourist establishments is the most desirable means of sanitary control. Prior to 1935, Indiana camps were controlled by a specific regulation of the Indiana State Board of Health, but due to a limited personnel it was impossible to properly enforce this regulation. Since that year tourist camps have been required to obtain a license. The present camp regulation is essentially the same as the one used earlier, but the fact that licenses will be withheld if the regulation is not met has greatly simplified sanitary control.

During 1936, there were 389 camps licensed, and 128 closed. Most of the camps were closed voluntarily after it was learned that the expenditure of a considerable amount of money would be required to make them eligible for license. Only two owners were prosecuted, although county attorneys assisted in about 15 other cases. During 1937, there were 501 camps licensed, and approximately 100 closed. The assistance of attorneys was required in about the same number of instances as in 1936. These figures show that a camp-licensing program can be used to obtain the desired results without jeopardizing the educational value of the camp-survey program.

B. A. Poole
Chief Engineer, Bureau of Sanitary Engineering, Indiana State Board of Health

Indianapolis, Ind.
December 27, 1937

Planning for Subsurface Utilities in Chicago

To the Editor: In connection with the article on "Principles of Subsurface Utility Planning," by Henry H. Kranz, M. Am. Soc. C.E., in the October issue of Civil Engineering, I would like to describe the plan for utility location which is now in effect in Chicago.

Advance planning for the location of the subsurface structures of the various utilities occupying the highways, particularly in the more congested sections of our larger cities, has long been recognized by the Bell System as a matter of major importance and one which should be of real value to the public and the utilities alike. Proper planning for the location of underground structures requires that a coordinating medium be established, by means of which the existing plant and future requirements of each of the utilities may be molded into one comprehensive plan for the allocation of the subsurface space which will result in the most practical and economical arrangement obtainable.

In Chicago the coordinating medium is the Board of Underground Work of Public Utilities of Chicago, which was organized in 1910 and is a self-constituted body without statutory powers. This Board now has fifteen members, consisting of the Commissioner of Public Works, who is the chairman, representatives of the Board of Local Improvements, the Department of Streets and Electricity, the Cook County Board, the Chicago Park District, the Sanitary District, the State Department of Public Works, and each of the eight major utilities. There is a permanent secretary, who carries on the work of the Board under the direction of an Executive Committee consisting of eight members. His salary is paid by the privately owned utilities.

The Board functions in an advisory capacity and provides a common meeting ground for the utilities and the various governmental bodies concerned in the planning and execution of all public and large private improvements. In all cases of public improvements the Executive Committee, with the approval of the Board, prepares not only an assignment of space for each of the subsurface structures involved, but also a schedule of the time and sequence of each of the underground operations which is made to conform with the schedule for the improvement. The contractors for the various parts of the work are able to complete their schedules in an orderly manner, with a minimum of interference with other contractors and without unnecessary delays.

Whenever any utility represented on the Underground Board contemplates a major extension of its underground facilities, it obtains, through the Secretary, complete and up-to-date records of all existing subsurface structures of the other utilities. The assignment of space is made by the Board, consideration being given to the requirements of all the utilities.

The Underground Board does not maintain records of existing subsurface structures. It has been found that in all cases where accurate and complete records of the underground plant of each of the utilities are required, they can be quickly furnished from the regular records, which the utilities must keep for the proper operation of their business. This method of procedure has proved entirely adequate and satisfactory for all the varied conditions encountered in Chicago, and the cost has been almost negligible as compared with the cost of a centralized composite record of all underground structures.

In Chicago, the Underground Board does not maintain any plans covering the future allocation of subsurface space but considers only the specific cases as they arise. It has been our experience that, due to changes in the trends of the city's development, to new factors that arise, and to the frequent improvements and changes in the telephone art, it would be impracticable to attempt to conform to a rigidly established plan of development.

L. R. Mapes
Chief Engineer, Chicago Area,
Illinois Bell Telephone Company

Chicago, Ill.
December 28, 1937

Subsurface Utility Planning in District of Columbia

To the Editor: In his article on "Need for Subsurface Utility Planning," in the October issue, A. W. Consoer, M. Am. Soc. C.E., has very clearly set forth the need of advance planning, and his paper should certainly stimulate interest in this subject among city officials.

In Washington, D.C., it was recognized some thirty years ago that subsurface structures must be planned in advance, and must be installed along prearranged lines. Otherwise, it was believed they would grow in a disorderly manner, resulting in the wasteful occupancy of public space, and inconvenient locations, ultimately causing obstructions to traffic and interference with their own future growth.

In July 1908, the Commissioners of the District of Columbia created a Board of Underground Construction, Public Service Corporations, which at the present time is made up of the Director of Sanitary Engineering, the Director of Highways, and the Director of Inspection. The creation of this Board has resulted in the designing of a systematic method for the extension of underground construction, including sewer and water lines, with a view towards the greatest possible conservation of public space.

In connection with the installation of underground construction, study is given to all plans for proposed extensions to insure their conformity to established zoning plans. These structures embrace telephone, telegraph, electric light, power; steam, oil, and gas mains; tunnels, vaults, and fuel oil tanks; privately owned conduits and pipe lines, and all other structures in public space, including the city cables, municipal sewers, water mains, and, to a degree, plumbing work connections thereto.

The Section of Underground Construction set up to have charge of this work prepares all permits for such underground structures except for sewers, water, and plumbing, incorporating therein such construction procedure conditions as necessary. In addition, careful studies are given those applications for permits that necessitate the cutting of improved roadways laid within the decade antedating the applications, with the view of eliminating such cuts if possible.

During the installation of utility structures, inspections are made for compliance with the conditions of the permits, and field book sketches, showing detailed measurements of the new work as well as of old structures encountered in the excavation, are prepared.

After the work has been completed, detailed record sheets, drawn to suitable scale, are prepared and filed. The work is also plotted on record maps of 50-ft scale. In addition to a card index of all permits prepared, a reference card is also made for each installation. This card affords a brief of the amount of work done, the amount of the inspection charge therefor, index to field book and page, start and completion dates, record file numbers, and other pertinent information. In addition to these 50-ft scale maps, which at present number 875, there are about 53 maps of 10-ft scale, covering important street intersections.

The inspection fees as set up are of necessity modified from time to time, but in general they have been unchanged for the last twenty years. In Washington, the sizes of gas mains most frequently installed are of 4 and 6-in. diameter, and the size of conduit most frequently installed is 4-duct. Under the method of computing charges, the inspection fee for each of the above sizes is 2 cents per linear foot; for a 16-in. main or 16-duct conduit, the charge is 4 cents per linear foot.

The personnel required in the Section of Underground Construction consists of one engineer at a salary of $3,800, two inspectors, two draftsmen, and one clerk. Together with the maintenance of an automobile and driver, the total operating expenses of the office are about $13,877 per annum.

J. B. Gordon, M. Am. Soc. C.E.
Director of Sanitary Engineering
for the District of Columbia

Washington, D.C.
December 18, 1937

Variation in Bearing Capacity of Soil

TO THE EDITOR: I was much surprised to read in the article on "The Scientific Method in Earthwork," by Glennon Gilboy, Assoc. M. Am. Soc. C.E., in the December issue, that in the proposed revision of the Boston building code a reduction in bearing value is provided for small footings.

It has been generally recognized by engineers that, except for loose, dry sand, the bearing capacity of soil varies with the size of the loaded area, and that this variation can be expressed by the statement that the larger the area the smaller the bearing capacity.

This relationship has been expressed by W. S. Housel, Assoc. M. Am. Soc. C.E., in an equation that has been found to conform very satisfactorily to test data (See page 273 of *Bulletin No. 13* of the University of Michigan, and page 309 of Vol. 93 (1929) of the TRANSACTIONS of the Society).

PAUL ANDERSEN, Assoc. M. Am. Soc. C.E.
Assistant Professor of Structural Engineering, University of Minnesota

Minneapolis, Minn.
December 30, 1937

A Tunnel Under the Straits of Mackinac

DEAR SIR: In discussing the paper on "The Proposed Mackinac Straits Bridge," by James H. Cissel, M. Am. Soc. C.E., in the October issue, I offer with considerable trepidation some preliminary ideas on the possibility of a submerged tunnel, arranged to float or not to float, depending upon the desired gradients. A 30-ft cylinder partially lined as indicated in the diagram, Fig. 1 (*a*), provides space for a two-lane highway and buoyancy enough for any anticipated live load—say 4,000 lb per lin ft. (It would probably be necessary to add steel scrap to the concrete to make it weigh 200 lb per cu ft.) If such a cylinder can be made and held against rising or drifting, the essential conditions of our problem are solved.

A four-mile current against a 30-ft tube induces a horizontal thrust of a ton to the foot. A concrete anchorage block with cutting edges on the bottom can be lowered and dragged until sufficient resistance is built up to withstand both horizontal and vertical forces—and no doubt study would provide other ideas. After placement, anchorage blocks should be tested before permanent attachment to the tunnel tube.

If the tube is made heavy enough to lie on the bottom, Fig. 1 (*b*), anchorage will not be needed. Concrete or steel piles, which can be driven through stuffing boxes in the sides of the tube, will hold the tunnel in position, and at Mackinac the grades are not excessive for vehicular traffic, although too great for a railroad.

Tunnel sections, say 1,000 ft long, might be built on shore and launched. A simple calculation shows that 13-ft vertical shafts, spaced every 500 ft, will allow the tunnel to reach equilibrium at a submergence of 50 ft, in which position the floating design is made fast to the anchorage. If the tunnel is to rest on the bottom, the vertical shafts for buoyancy would naturally be smaller.

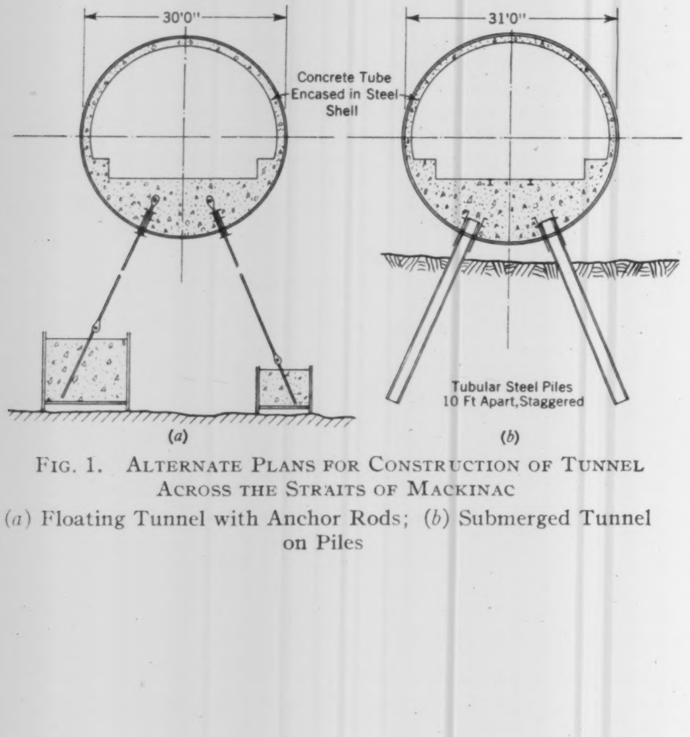
30'0"
31'0"
Concrete Tube Encased in Steel Shell
Tubular Steel Piles 10 Ft Apart, Staggered
(a)
(b)

FIG. 1. ALTERNATE PLANS FOR CONSTRUCTION OF TUNNEL ACROSS THE STRAITS OF MACKINAC

(*a*) Floating Tunnel with Anchor Rods; (*b*) Submerged Tunnel on Piles

Sufficient study has been made to indicate that the ends of tunnel sections can be joined under water, if bulkheads are provided near each end. After the two ends have been pulled into position, the bulkheads provide a small chamber which can be unwatered, the permanent connection being made under normal atmospheric pressure.

The following estimates of cost are based on the use of steel for tube and anchorage, assuming that steel submerged in fresh water does not corrode. I have nothing definite to support this assumption, and research would be necessary. As an alternate the tunnel could, of course, be built of reinforced concrete and the anchorage probably of some non-rusting material. I have assumed that the railroad track, if any, will be laid on the highway floor, as it seems possible that railroad traffic could be coordinated so as not to greatly interfere with the use of the highway. There is also the question of anchorage against temperature changes. Preliminary figures show that abutments weighing at least 10,000 tons would be required.

My estimated cost for the floating tunnel is as follows:

20,000 ft @ $600	$12,000,000
Portals and entrance	1,000,000
Ventilation	3,000,000
Field plant and equipment	1,000,000
Engineering and research	3,000,000
Total	$20,000,000

For a non-floating tunnel resting on the bottom:

13,000 ft @ $600	$ 8,000,000
Entrances	1,000,000
Approaches	1,500,000
Ventilation, field plant, and engineer	7,000,000
Total	17,500,000

Approximately 80 per cent of the items comprising such an estimate are within our experience, and I believe ample. Allowances for sinking and fastening the tubes under water are, of course, something of a guess, but perhaps not so much so as an estimate on bridge piers in 250 ft of water.

These estimates indicate that the probable cost of a tunnel would be less than one-half that of a bridge. If the project is being seriously considered, the use of such a tunnel is surely worth investigation. In fact, these ideas might also be found applicable in other locations.

GEORGE T. HORTON, M. Am. Soc. C.E.
President, Chicago Bridge and Iron Company

Chicago, Ill.
December 18, 1937

Recollections of Past-President Chanute

TO THE EDITOR: The article on Octave Chanute, Past-President of the Society, in the December issue, gave a very good picture of that delightful old Frenchman.

In 1888 I was on the Santa Fe, stationed on the residency running west from Sibley Bridge, on which Mr. Chanute was consulting engineer and the late John Findley Wallace, M. Am. Soc. C.E., resident engineer. I met both of them a number of times on the work. Mr. Chanute was in the office at Kansas City, where I had to spend four or five days each month, and I also saw quite a lot of him on those visits.

In 1900, Mortimer E. Cooley, Hon. M. Am. Soc. C.E., the late Theodore H. Hinchman, M. Am. Soc. C.E., and I had the joint job of bossing 150 engineers on the Michigan Railroad appraisal, the first job of the sort ever undertaken. Governor Pingree appointed Colonel Chanute chairman, and George W. Vaughn, Charles Hansel, and Charles E. Greene, all Members of the Society and all deceased, as a Board of Review and Consultation, and for six months we had them with us four or five days every month. Every evening the seven of us, usually with three or four of our principal men, had dinner at the Detroit Club and spent the evening discussing the work, and visiting. Colonel Chanute was a delightful story teller, and was fond of indulging in day dreams of the time when men would fly, and was distinctly the life of any group he was with. That last association, in addition to the grown man and youth acquaintance of a dozen years before, made me feel that he was truly a friend.

Colonel Chanute was not a tall man—perhaps 5 ft 8—slight and straight, as neat and dressy as a fashion plate. Always soft spoken and courteous, he was indeed a grand gentleman.

I do not know where he got the "Colonel" that everyone used, but I presume that it was in Civil War Service. The city of Chanute, Kans., was named for him, and he rated as one of the men whom Kansas looked upon as her own, although so far as I know he never lived there.

Henry E. Riggs, M. Am. Soc. C.E.
Honorary Professor of Civil Engineering
University of Michigan

Ann Arbor, Mich.
December 28, 1937

A Bridge for the Straits of Mackinac

To the Editor: The paper on "The Proposed Mackinac Straits Bridge," by James H. Cissel, M. Am. Soc. C.E., in the October issue, is an excellent presentation of a project that should receive thoughtful consideration by the citizens of the state of Michigan. This state presents the anomaly of a political unit made up of two peninsulas without any land connection, except by way of another state. Such being its geographical condition, it behooves the state of Michigan to "get together" by means of some physical connection more adequate than the present ferry system, particularly as the tips of the two peninsulas are only four miles apart.

Professor Cissel has well proved the impossibility of meeting the growing demand for transportation across the Straits of Mackinac by ferries alone, without an uneconomical and fast-rising expenditure of state money. He has also shown the impossibility of maintaining adequate service during the three winter months, because of storm and ice conditions, no matter how much money is spent on ferries and ferry slips.

From a study of ferry-traffic growth since 1923, Professor Cissel estimates that the probable traffic demand on the ferries will be 580,000 vehicles during 1942. His charts indicate this estimate to be fairly conservative. But let us project the figures an additional ten years, to the year 1952, or ten years after a bridge might be completed. If bridge facilities are available that year, providing uninterrupted service winter and summer, 50 per cent more vehicles than the ferry estimate would very probably pass over it, making a total for 1942 of 870,000. If this traffic increased 15 per cent for five years and then 10 per cent for the following five years, the number of vehicles for 1952 would be 2,850,000, which we believe is a conservative estimate.

Assuming a toll charge of $1 per vehicle and using Professor Cissel's estimate of $250,000 from railroad tolls, the gross income would be $3,100,000. Applying his estimate of $2,000,000 for capital and operating charges, leaves $1,100,000 for the year 1952 for amortization of bonds. There is therefore a reasonable expectation of amortizing a $35,000,000 bond issue in the usual period of 30 to 40 years.

Although the population and number of industries in the upper peninsula are not at present very large, they will undoubtedly grow rapidly if stimulated by a Straits bridge. As for as toll revenue is concerned, the fact should not be overlooked that a bridge across the Straits would be in an extremely strategic position regarding highway communication with the Province of Ontario, as well as the Upper Peninsula.

Table IV in Professor Cissel's paper gives $13,500 for preliminary expenses. This seems entirely too small. At least $200,000 should be appropriated for investigation, for making adequate borings, and for study of comparative designs. Such a preliminary fund is often hard to obtain but is always repaid by economies effected and should be the first step in the financing of the bridge.

Many state highway officials are confronted with the fact that millions of dollars are being spent on wide, smooth, curve- and grade-eased highways that are interrupted at frequent intervals by bottlenecks, created by narrow and obsolete bridges, which cannot be replaced for lack of funds. Frequently a fine highway comes to an end because there is no bridge at all. This is exactly the case at Mackinaw City and St. Ignace. In short, obsolescence of existing bridges, or lack of connecting bridges, accounts for the weakest links in the highway systems of every state. It seems a reasonable request, as a step in the improvement of our highway systems, that a stop should be put to the ballyhoo of gasoline tax diversion as it affects our highway bridges.

Charles F. Goodrich, M. Am. Soc. C.E.
Chief Engineer, American Bridge Company

Pittsburgh, Pa.
December 24, 1937

Importance of Study of Flow on Steep Slopes

To the Editor: We concur fully with the conclusions reached by John Hedberg, Jun. Am. Soc. C.E., in his article in the September issue, regarding the importance of study of the condition of flow on steep slopes. Flow on steep slopes is common at dams where the spillway channels, in many cases, have slopes much greater than those used in irrigation channels. Modified formulas similar to those of the author are used in such channel computations. We wish to give some additional comments relative to statements expressed by Mr. Hedberg.

First, from the standpoint of theory, the statements concerning the modified expressions for pressure and velocity head are correct within the limitations mentioned. The question arises as to what would be the difference in the water level computed by the two methods—ordinary and modified. Expressing the energy content at any point of the channel as E, and using primes to indicate the modified values, we obtain the energy expression through the elements of any consecutive section as follows:

$$E = E' = h_v + d + h_f = h_v' + d'\cos\theta + h_f' \ldots\ldots [1]$$

where h_f is the head loss due to friction.

Let $c = h_f/h_v$, and $n = d'/d$. Substituting, and assuming $c = c'$,

$$1 = \frac{\lambda}{2}(1 + c)\,\frac{1 - n^2}{n^2} + n\cos\theta \quad \ldots\ldots\ldots\ldots [2]$$

where $\lambda = 2h_v/d$, the kinetic flow factor.

Table I gives the percentage variation of the depth as computed by modified formulas for a slope of 30 deg., from that computed by the ordinary formulas. The values of λ are all for flows above the critical. The values of c were assumed from an actual example. However, it was found by computation that, regardless of the value assumed for c, the value of n is not appreciably affected. Table I indicates that for a flow with high velocities, and consequently with a high kinetic flow factor, the modified depth does not differ materially from the depth computed by the usual method.

Table I. Variation Between d' and d

λ	$c = c'$	n	% variation of d' from d
1	0.03	0.78	—22
2	0.04	0.91	— 9
3	0.05	0.95	— 5
4	0.06	0.96	— 4
5	0.07	0.97	— 3
6	0.08	1.0	0
7	0.09	1.0	0

So much for the "theory," which does not include several important factors. Mr. Hedberg emphasized the importance of the uneven distribution of the velocities. The air friction on the surface and the entraining of air seem to be other factors to contend with. Phenomena similar to one described by W. H. Holmes, Assoc. M. Am. Soc. C.E., in "Traveling Waves in Steep Channels" (Civil Engineering, July 1936), should also be considered.

In conclusion, we believe that the so-called "laboratory" experiments have a very limited value in application to the actual flow conditions. Laboratory experiments are helpful in establishing the character of the phenomenon, but when it comes to estimating numerical values of more intricate phases of flow, the experiments with flumes of small size usually carried on in a laboratory do not have sufficient value. In order to obtain the coefficients to be applied to full-size structures (spillways, siphons, chutes, and so forth) the tests should be made on models as near full-scale as possible. This is the direction in which modern experimentation should go.

I. M. Nelidov, Assoc. M. Am. Soc. C.E.

Sacramento, Calif.
December 23, 1937

Formulas for Combined Flexure and Direct Stress

DEAR SIR: The formulas given by Francis P. Witmer, M. Am. Soc. C.E., in his article, "Basic Formulas for Combined Flexure and Direct Stress," in the December issue, may be extended to include the case where P or T acts at a distance e (eccentricity) from the axis of the column or beam as in the accompanying Fig. 1. In this case Eqs. 7 and 8 become, respectively:

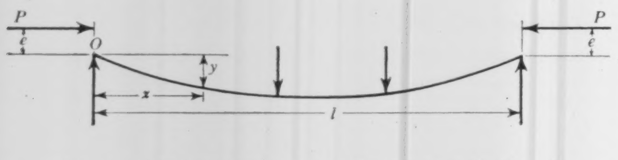

FIG. 1. MODIFICATIONS OF MR. WITMER'S FIG. 1

$$\frac{d^2y}{dx^2} = -n^2(e + y) \quad \ldots \ldots \quad [14]$$

$$\frac{d^2y}{dx^2} = +n^2(e + y) \quad \ldots \ldots \quad [15]$$

The solution of these differential equations will be of the form, respectively:

$$y = A \sin nx + B \cos nx - e \quad \ldots \ldots \quad [16]$$

$$y = Ae^{nx} + Be^{-nx} - e \quad \ldots \ldots \quad [17]$$

Combining with Eqs. 12 and 13, the following formulas are comparable to Eqs. 1 and 2, respectively:

$$y = A \sin nx + B \cos nx - e + \frac{X}{P} - \frac{d^2X}{n^2Pdx^2} \quad \ldots \quad [18]$$

$$y = Ae^{nx} + Be^{-nx} - e - \frac{X}{T} - \frac{d^2X}{n^2Tdx^2} \quad \ldots \quad [19]$$

Euler's formula is derived from Eq. 1, and the secant column formula is derived from Eq. 18 (see Swain's *Strength of Materials*, pp. 420 and 434).

K. L. DEBLOIS, Assoc. M. Am. Soc. C.E.
Associate Highway Bridge Engineer,
U. S. Bureau of Public Roads

San Francisco, Calif.
December 22, 1937

[*Editor's Note:* In the article under discussion there were two typographical errors. In the formula following Eq. 11, the sign of equality preceding the third term should be a minus sign. In the third line from the end, the quantity P should not appear in the expression for M.]

Local Planning Improvements Important

TO THE EDITOR: In the article, "Thoroughfare Plans and Urban Areas," in the December issue, Frank H. Malley, Assoc. M. Am. Soc. C.E., has given a complete survey of the thoroughfare problems of Metropolitan Boston, especially as they affect the numerous urban centers of that region.

When these centers were established, the early settlers used Massachusetts Bay and its rivers for transportation purposes, and highways as we know them today were practically non-existent.

In time these early settlements grew into cities and towns, and the residential sections moved farther and farther into the open country where streets were built wider, but the streets in the original sections were not widened proportionately. With the arrival of the automobile the situation became serious. Town, city, and district planning boards have been struggling with the problems created by the automobile with commendable success, but they have a long road ahead of them yet.

The network of thoroughfares serving the urban areas of Metropolitan Boston may be likened to the main line of a railroad system. They have been given major attention as were the main lines of railroads during the past century. But whereas railroad officials have been concentrating in recent years upon the development of terminal facilities, our highway departments have, to a considerable extent, restricted their activities to the expansion of main thoroughfare systems. Our four-, six-, and eight-lane thoroughfares are rendering great service, but they will be worth what they cost only when urban areas have interior thoroughfares affording a free flow of traffic within as well as into and out of them.

Unless ample means is provided for the circulation of traffic within the business and industrial districts of urban areas, decentralization will increase to the point where it may get out of control, with the result that such communities will be broken up and property values destroyed. A few statistics may illustrate this point.

Let us assume that the congested portion of Metropolitan Boston consists of the cities of Chelsea, Everett, Somerville, Cambridge, and Boston, to be designated as the "central zone." In the year 1905, which was about the beginning of the automobile era, 35 per cent of the population of Metropolitan Boston lived outside the central zone, and 65 per cent within it. In 1935, the latest year for which population data are available, 44 per cent lived outside the central zone and 56 per cent within it. In 1905, as regards assessed valuation of real estate, 26 per cent was outside the central zone and 74 per cent within, while in 1935, 43 per cent was outside and 57 per cent within. In other words, in a period of 30 years the outer zone increased 9 per cent in population and 17 per cent in real estate valuation at the expense of the central zone.

The shifting of real estate values is a real danger signal, indicating that instead of business and industry taking up the slack due to the shifting of population, these activities are themselves moving out of the central zone. This movement must be charged, to a considerable extent, to traffic conditions.

What can be done about this? The source of funds for adequate street widenings and additions in the near future seems uncertain. Decentralization can be permitted to run wild, with (for example) the Boston business district approaching the condition that it was in after the great fire. As an alternative, while striving for the major projects which have been developed and kept up to date by our planning boards, we can try to cure some of the local sore spots in the meantime.

A program of local improvements might start with the adjustment of curb intersections and sidewalk and pavement widths to conform with local needs. Then might follow a gradual reduction of the privilege of turning at any and all intersections, together with an attack upon the parking problem. Traffic regulation should be an important part in the studies of any planning board. There might follow the elimination of bottlenecks by widening, traffic circles, or grade separations. Small amounts of street construction might complete projects which for some reason were temporarily abandoned. A gradual improvement and extension of rapid-transit facilities is well within the scope of such a program.

It might also be desirable to study seriously what has been called arcading of highways in commercial districts. If we are daring enough to go one step further and consider double-decked thoroughfares, including arcading and the judicious use of ramps, we will have made a real attack upon the problem of rejuvenating our urban areas.

A. B. EDWARDS, M. Am. Soc. C.E.
Engineer, Division of
Metropolitan Planning

Boston, Mass.
December 30, 1937

Checking Marine Borers in Cape Cod Waters

TO THE EDITOR: In connection with William F. Clapp's article on "Recent Increases in Marine-Borer Activity," in the December issue, I would like to outline briefly the investigation carried on by the Massachusetts Department of Public Works along the coast line of Massachusetts south of Boston Harbor and, more in detail, that portion of the coast line south and west of Cape Cod.

During the past few years test boards on this section of coast line have been maintained by the Department and examined monthly at the following points: Scituate, Plymouth, the east and west ends of Cape Cod Canal, Chatham, Hyannis, Marion, and New Bedford. In a general way, these test boards have shown limnoria at all locations, and teredo occasionally at the two most northerly points and in practically all cases at the other points with pronounced attack at certain of the ports. The greatest damage by teredo was found at Hyannis, Marion, and New Bedford. At New Bedford chelura was also found on a few of the test blocks.

As a result of the early investigation an appropriation to cover more detailed examination was made by the legislature. Since the funds appropriated were not sufficient to cover the entire waterfront, it was decided to begin on the structures owned by the Commonwealth and, second, to examine the structures of New Bedford and Fall River harbors where teredo was most prevalent.

The work was carried on by a party consisting of a diver, tender, two boatmen, and a recorder. A plan of each wharf showing pile bents was first prepared, so that each pile could be identified later. The diver made a careful examination of each pile and reported its condition to the recorder by telephone. If the pile showed evidence of outside deterioration, a core boring was taken to find how deep the borer had penetrated, and these core borings were tabulated and submitted to the office for further examination. The field work in the two harbors referred to is finished, but a complete office record of the results is not yet available. In one instance however, a wharf was found to be in such poor condition that the owner was ordered either to make repairs or reduce the loading on the structure. The total number of piles examined at New Bedford was 4,390, of which 1,406, or about 32 per cent, showed some worm attack and 325, or about 7 per cent, were eaten away so that less than 25 per cent sound wood remained. The total number examined at Fall River was 2,610, of which 1,556, or about 60 per cent, showed some worm attack and 471, or about 18 per cent, showed less than 25 per cent sound wood.

In New Bedford Harbor 1,614 of the total number of piles examined were creosoted, and these treated piles showed materially greater resistance to attack than did the untreated piles. Of these treated piles, 29, or about 2 per cent, showed slight damage, and about four-tenths of 1 per cent showed serious damage. Of the 2,676 untreated piles that were examined, 1,377, or about 50 per cent, showed some damage and 318, or about 11 per cent, showed 75 per cent or more eaten away. These percentages compare fairly closely with the percentages observed in Fall River Harbor where no treated piles were found. Piles showing only 25 per cent sound wood were considered of no value, as a more thorough examination would doubtless have shown worm activity even in the wood reported sound.

There was no damage to creosoted timbers in the piers at New Bedford and at the west end of the Cape Cod Canal, but untreated oak fender piles were found to be badly damaged and, in many cases, completely severed by action of the teredo.

As a result of the tests and examinations made, the Department is considering the advisability of establishing rules restricting the type of construction authorized in tide-water to such type of construction as would resist or, at least, retard the activity of the various types of marine borers. It is believed that if construction which will allow the various types of borers to propagate is permitted, it constitutes a menace to adjacent structures or to vessels moored alongside the wharves.

FRANCIS L. SELLEW
District Waterways Engineer,
Massachusetts Department of Public Works

Boston, Mass.
January 4, 1938

Howe-Truss Angle-Block Problem

TO THE EDITOR: It is interesting to note that mathematicians are still trying to solve the Howe-truss angle-block problem and, after an immense amount of labor, can get only results which are "approximately correct" or "near enough."

When I started to work for the Canadian Pacific Railroad, 54 years ago last May, I was fortunate to be under two unusually fine engineers—Walter A. Doane, M. Am. Soc. C.E., and P. Turner Bone. Mr. Doane was and is a past master of wooden bridge design. With his son, he is now consulting engineer in his home town of Meadville, Pa., and Mr. Bone has lived in Calgary ever since. I am thankful that both are still active and that they honor me with their correspondence.

Mr. Doane was responsible for the designs for all the wooden bridges from Medicine Hat, Saskatchewan, to the west slope of the Selkirks. Naturally we had many Howe trusses, with rods, bolts, and in some cases cast-iron angle blocks. These used little iron, and the bulk of the material was, of course, wood, which was cut and hewn at the site—before the railroad tracks were extended there.

We had Prof. P. H. Philbrick's mathematical formula, which was supposed to give results "near enough." It was published in the May 1881 number of *Van Nostrand's Magazine*. But we did not use any mathematical formula for designing angle blocks, as we were able to get correct results, in a fraction of the time, by a simple graphical method (Fig. 1).

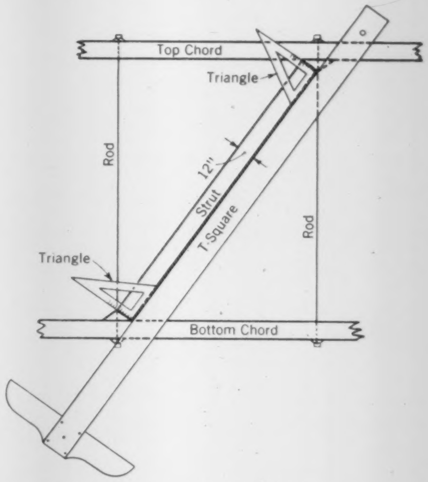

FIG. 1. GRAPHICAL METHOD FOR FINDING LENGTH OF STRUT AND ANGLE OF FACE OF ANGLE BLOCK OF A HOWE TRUSS

A correctly designed Howe truss should have the diagonal struts cut square at each end, with full bearing (neither more nor less), on the inclined face of the angle block. If the strut is wider than the face of the angle block, then the end of the strut must be beveled. On the other hand, if the squared end of the strut does not cover the whole of the inclined face of the angle block then there would be danger of the strut's slipping.

The problem, therefore, is to find the maximum length of the strut for a given panel and the angle of the face of the angle block. This is done graphically, in much less time than it takes to write about it, as follows:

Draw a panel to a convenient scale, the vertical measurement being the distance between the top and the bottom chords and the horizontal measurement the distance from center to center of the vertical rods; then cut two paper triangles and on the edges of these triangles mark off a scale. Place the triangles against a T-square as shown, and move the T-square and triangles, until (if the strut is 12-in.) the 12-in. marks on the triangles touch the insides of the panel. It is then very easy to scale the length of the strut and the dimension of the angle block. We found a scale of 1 ft to 1 in. gave very satisfactory results.

This short cut makes me think of one given me by another great engineer, Charles Conrad Schneider, Past-President (1905) of the Society. He probably did more to develop the design of iron and steel bridges than any other engineer. His designs were always of the best.

When I worked for him, in 1888–1890, he was chief engineer of the Pencoyd Bridge Company. Later he was the first chief engineer of the American Bridge Company. I showed him about a dozen mathematical calculations I had made to determine the deflection of draw bridges, when open. The elaborate formula, which considered each and every member of the truss separately and then combined the results, involved much laborious calculation, tedious to say the least. Mr. Schneider looked at my calculations and laughed, saying that he had a better rule, which was to allow one-sixteenth of an inch for each 10 ft of span.

His rule gave the same results I had obtained for the dozen bridges.

T. KENNARD THOMSON, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
December 21, 1937

Shortcuts in Use of Slide Rule

TO THE EDITOR: Time-saving devices such as that described by William E. Davidson, Jun. Am. Soc. C.E., in "A Handy Slide-Rule Shortcut," in the December issue, are always interesting and frequently useful. For this particular one I suggest a variation that reduces the total number of operations while accomplishing the same algebraic transformations. Using Mr. Davidson's illustration $\sqrt{35.3^2 + 20.6^2}$, set the C-scale left index on the D-scale 20.6 and move the runner to 35.3 on the D-scale. Read 2.94 under the runner on the B-scale, add 1, and move the runner to the resulting 3.94 on the B-scale. On the D-scale under the runner read the square root of the sum of the two squares, 40.9.

This procedure applies equally well, with suitable modifications, to the difference of two squares. For the square root of $\sqrt{40.9^2 - 20.6^2}$, set the C-scale index on the D-scale 20.6 and move the runner to the D-scale 40.9. Subtract 1 from the 3.94 read under the runner on the B-scale, and move the runner to the resulting 2.94 on the B-scale. Read the difference of the squares, 35.3, under the runner on the D-scale.

In these operations the decimal point in the square of the ratio, read on the B-scale, must be used correctly. Also it must be observed that the number obtained by adding or subtracting 1 from the square of the ratio may fall off the scale making it necessary to set the slide back one length (that is, to place the right index where the left one was) or the reverse.

It should be added that slide rules are available with special scales for these operations which are common in vector manipulations in electrical engineering work.

DONALD D. CURTIS, Assoc. M. Am. Soc. C.E.
Professor of Mechanics and Hydraulics,
Clemson College

Clemson, S.C.
December 23, 1937

Some Advantages of a Thoroughfare Plan

TO THE EDITOR: The article on "Thoroughfare Plans and Urban Areas," by Frank H. Malley, Assoc. M. Am. Soc. C.E., in the December issue, admirably sets forth the advantages of adopting a comprehensive plan for thoroughfare systems. Few will question Mr. Malley's thesis that a comprehensive thoroughfare plan is indispensable to the proper development of a municipality or region. Unfortunately, the cost of revamping an existing thoroughfare system to meet entirely the necessities of modern automobile and truck traffic is staggering. In fact, in most cases, it is impracticable to carry out a comprehensive scheme which will entirely take care of even the worst conditions, except over a relatively long period of time. However, this condition should not discourage the planner from laying down a proper plan which may eventually be realized; nor should it prevent him from insisting that such improvements as are made shall follow this plan. Considerable improvement in traffic conditions can be accomplished by only moderately expensive changes in present facilities, pending the time when the comprehensive plan can be brought to full realization. The improvements which have been made in the automobile and the increase in number are such that, with some notable exceptions, our highway systems are far behind the development of the automobile.

As a commentary on the great cost of remodeling highway systems, an official of the U. S. Bureau of Public Roads has estimated that if all the money expended by the government for federal-aid highways during the past twenty years, together with the funds provided by the states for use on the same highways, were applied to the modernization of the present state highway systems, by elimination of dangerous grade crossings, widening roadways, and by-passes, only about 5 per cent of these systems could be remodeled, and that even this small percentage would involve an expenditure of approximately four billion dollars, or an average cost of about $250,000 per mile. In cities and adjacent regions the cost would, of course, be much higher on account of the cost of the and. In the Westchester County (New York) system some of the parkways cost a million dollars a mile.

Undoubtedly more and more attention is being given to highway design under the category of "built-in" safety. The lengthening of sight distances, proper superelevation at curves, longer radius of curvature, separation of traffic traveling in opposite directions, separation of grades at crossings, and efficient lighting are all being built into the modern highway. As Mr. Malley points out, bottlenecks and intersections are the principal cause of the slowing down of traffic.

Mr. Malley is undoubtedly correct in stating that the adoption of a comprehensive plan will stabilize land values. The construction of properly designed trafficways will also increase land values. The experience of the Westchester County (New York) Park Commission is an excellent example of this fact. A survey of land values made after the construction of some of the principal parkways showed that values in the vicinity of the parkways had increased as much as four times. On the other hand, a highway system of ordinary design will very often not greatly increase the value of areas through which it passes, due to the fact that the adjacent areas have not been properly zoned to prevent such cheap developments as roadside stands, low-grade real-estate ventures, and the like. This emphasizes the additional values of the parkway or freeway systems, where the entrances are restricted, where the marginal strip is properly landscaped and developed, and where adjacent lands are adequately zoned. Although this latter type of development is more expensive to construct, it nevertheless brings the greatest return in the enhancement of land values.

The main problem confronting the planner and highway engineer of today is to determine the extent to which it will be economically possible to remodel thoroughfare systems to keep abreast of the development of the automobile. The system which Mr. Malley has described for Boston and its vicinity, the system in Detroit and Wayne County, Michigan, the Westchester County (New York) Parkway System, and the Long Island (New York) Parkway System—these are all excellent examples of the manner in which the problem may be attacked with some assurance of success.

LESLIE G. HOLLERAN, M. Am. Soc. C.E.
Consulting Engineer for WPA

New York, N.Y.
January 4, 1938

Development of Recreational Areas in New Hampshire

TO THE EDITOR: It was with surprise and pleasure that I saw the familiar outline of the Belknap Mountain range on the Page of Special Interest in the December issue of CIVIL ENGINEERING. These mountains are in my home town of Gilford, N.H., and my father owned an 80-acre pasture lot on the slope of the third mountain (to the right).

I understand their summits are now lined with ski trails, which are visited by many people coming up on "snow trains" from Boston, during the winter season. As a boy, I had an active part in winter work in the woods, but the trails we made then were not ski trails.

I understand a recreational area is being developed (presumably by the state) in the "back of the mountain" district beyond this range. In listing the various features provided there for winter sports, it is stated that parking space is available for 2,000 cars—this in a region where the main winter occupation of the inhabitants used to be the hauling of cord wood to market with ox teams.

It would be hard to find a more beautiful setting of natural scenery anywhere than the combination of lake and mountain scenery as viewed from the hill and mountain tops of this town. Lake Winnipesaukee, with its twenty miles of length interspersed with numerous islands, lies to the north, with the northern mountain ranges beyond and the auxiliary lakes of Paugus, Opechee, and Winnisquam to the west.

J. Y. JEWETT, Assoc. M. Am. Soc. C.E.

Paso Robles, Calif.
December 29, 1937

SOCIETY AFFAIRS

Official and Semi-Official

Henry Earle Riggs, President for 1938

Dr. Henry Earle Riggs
President American Society of Civil Engineers

It is always true that the office of President of the Society goes to a worthy man. In some cases the election is primarily a matter of honoring an individual, and in others it is a recognition of a record of accomplishment in the Society—an effort to capitalize on proved talents and a wise decision to take advantage of known willingness to be of service to the organization. Those that know Henry Earle Riggs will recognize immediately in which category he belongs. Few men in the history of the Society have worked more faithfully, more conscientiously, or more altruistically. During the last six years he has spent five on the Board of Direction, successively as Director and Vice-President. There he was known as a working member, and many of the more arduous committee memberships were assigned to his capable hands. No one has ever heard the criticism that when Dr. Riggs tackled a problem it was carelessly, partially, or slightingly handled.

A striking example of his fidelity to duty occurred early in his term of service. Not long after he entered upon his Board duties he suffered a severe automobile accident involving a broken leg among other injuries. To most men of almost seventy years this would have been an admirable excuse for lightening official burdens. But not so with Henry Riggs; to him it was simply a spur to greater effort—he refused to stay "down." He appeared at the very next meeting of the Board, although to do so required a trained nurse and a wheel chair. Every succeeding meeting witnessed his improvement. He was promoted to crutches and then to a cane. In all the time he missed not a single meeting of the Board, and none of his official activities showed any retardation. It took more than good sportsmanship to meet this crisis. Characteristically, he minimized the effort and the inconvenience.

A Rich Experience

Such an attitude is typical of a man who is used to meeting difficulties and to getting things done in spite of them. He has been a doer all his life. When only four years out of college, with that much experience on railroad construction and maintenance, he was made chief engineer of a 300-mile railroad in Michigan. After six years at this, he spent 16 in consulting work, having to do with steam and electric transportation and civic improvement. This gave him a splendid background for his life work, which he entered upon in 1912 as professor and head of civil engineering at the University of Michigan. After 18 years of service he retired in 1930 at the age of 65 and became honorary professor.

Throughout all his stay at Ann Arbor he has devoted a part of his talents to consulting work, largely connected with railroads and public utilities. He has thus become an expert in the field of valuation. One result also was a paper on this topic in the 1911 Transactions, and a second was participation in the notable 1917 report as member of the Society's special committee studying the valuation of railroads and public utilities. In these efforts he has served many a large and important private corporation, but if anything his services have been in even greater demand by governmental and public bodies.

Soon after coming to the university, Professor Riggs gave over the instruction in railroad engineering to others and devoted himself to teaching the legal side—engineering specifications and contracts. He wrote the lectures himself, and revised them every year. These courses were not stereotyped because he interspersed them with many bits of good common sense, drawing all his illustrations from his own personal experiences in order to show the students how to get along with other people and what to look for in the different situations of life. He was fond of telling them, "It's very easy to start things, but you are never known by the things you start, rather by the things you finish." Another of his favorite sayings is, "You can catch more flies with molasses than with vinegar."

Idealism in Practice

For thirty-odd years his work has been mainly in the investigation of public utility property. In addition, he is a good organizer and an excellent director of work in progress. People have come to rely upon him, knowing that if results are ordered for a specific time he can deliver them. In his professional work he has proved himself a good digger for long-forgotten facts. His fine analytical mind senses the importance of leads and details and thus approaches a conclusion logically. His selection of data is most judicious, and in his long experience of testifying before courts and commissions he has proved himself unusually resourceful.

In civic progress Dr. Riggs is an eager worker. He attends countless committee meetings and works always with an eye to the future. When he sees some feature that needs attention, he immediately takes steps to tell the right official about it and usually follows it up to see that the improvement is made. Even before he came to Ann Arbor, he was a member of the board of education in Toledo; later he was elected to a similar board in Ann Arbor and served as its president during a large building program for

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which he had seen a great need. Largely through his unceasing efforts, the building project was approved by the people, and he personally watched the construction almost daily.

His sense of fair play has always been strong. If he thought that anyone had not received a square deal and that something could be done about it, he did it. As head of his department at the university, he noted that quite a few students had dropped out without degrees, largely because of one particular course which had proved too strenuous. Some of these were fine men and, he observed, later made good engineers. On his own initiative he took up these cases individually as the years went by and in most cases secured degrees for the men, without forcing them to return to college.

Flowers have always been his hobby—a pleasant inheritance from his mother. As long as she lived he made it possible for her to have a place where she could have as many flowers as she wanted and could tend to them herself. When he built his new home in Ann Arbor he did all the landscaping personally. A prominent landscape gardener, after examining the result, remarked that it was the finest work he had seen in a long time. In particular, Dr. Riggs is proud of his rose garden, which blooms from early spring until Christmas. His sons have often observed that their father tried to teach them to wield the hoe but that until they had homes of their own, none of them appreciated the opportunity to learn.

On the purely personal side, Dr. Riggs would be considered by most people serious minded. Yet he loves company and his stories usually have to do with people and situations he has met. Rarely does he spin yarns for the fun of it. He is intensely fond of his friends and would go far to aid one in distress. While careful in financial matters, he is liberal in giving to charitable and social organizations.

This side of his nature is exemplified by his response to a great many calls for aid from his students. For example, a number of years ago a senior civil engineering student came to him with a serious personal problem. It seems that a new member of the family was expected, and while this was serious enough, the family economics were further complicated because the expectant mother was working in one of the college offices as the sole support of the family. Unless this man could borrow $500 on short notice he would have to drop out of school. Professor Riggs immediately took matters into his own hands, presented the situation to one of the local bank presidents, and offered to sign a note so that the student could get the money. The difficulty was solved; the boy remained in college and graduated; and the grateful couple are among the Professor's staunchest friends today.

On the diplomatic side also, he has plenty of natural ability. During a campus celebration one spring day an engineering student got into a "roughhouse" with a law student—by no means an unusual event. An officious "self-appointed" authority came along, seized the engineering student by the coat collar and took him in to Professor Riggs to find out his name. The Professor was unusually obtuse and could not recall the name although the young man was in one of his classes (which fact he did not disclose). The "official" made the young man sit down while he went in search of others to identify him. Fortunately this search became quite extended and provided the Professor with the opportunity to suggest to the culprit that the window seemed to be open. He disappeared and the identification failed to materialize.

The Riggs family have a right to be proud in their own name. It consists of 6 children, and now boasts in addition 19 grandchildren. It seems that no matter where the older folks are, they are not far from one of the children or grandchildren. Family ties are strong. Professor Riggs is of English origin, with a bit of Scotch mixed in. One of his old college associates proved the latter by an anecdote. One of Professor Riggs' sons-in-law has an estate noted for its extensive apple orchards. Because apples have little value as fruit, he is in the habit of following the example of the Arkansas hill billies—they do not harvest their corn down there, they bottle it. Being an engineer, this son-in-law gives an additional twist to his apples before bottling, and they are finally stored away in casks as applejack. There they remain through the years acquiring that marvelous bouquet associated with

"Sabean odors from the spicy shore
Of Araby the Blest."

On one of the Professor's visits to his son-in-law, he was asked by this friend to bring back a gallon of applejack, on the ground that it would be good for the friend's neuritis. The Professor brought back the gallon all right, but it was in two jugs; and he kept one of them—a canny Scotch trick.

To those casually acquainted with Dr. Riggs, he has the reputation of being an able engineer and a splendid citizen. Some have been fortunate enough to know him through the years and to them he is a cherished friend. During 1938 many Society members will have occasion to meet him and his life partner, or even to become intimate with him. The opportunity will be valuable and the pleasure will be mutual. As a multitude of Michigan men and other engineers will testify, Henry E. Riggs is well worth knowing.

Features of the Eighty-Fifth Annual Meeting

WITH A TOTAL registration of over 2,200, the Eighty-Fifth Annual Meeting set an all-time record for attendance. From near and far members of all ages gathered to take part in the general sessions and the committee meetings, to renew old acquaintanceships, and to enjoy the social activities that were interspersed throughout the four-day program.

The Meeting opened on Wednesday morning, January 19, 1938, with Vice-President Lupfer presiding. As usual, the feature of the opening session was the conferring of honorary memberships and prizes. Two of the newly elected Honorary Members—George S. Davison and Otis E. Hovey—were present in person for the award. The third, J. R. Worcester, was prevented by illness from attending and was represented by his son, Thomas Worcester. Especially impressive was the posthumous award of honorary membership to Hunter McDonald, whose family was represented by Albert F. Ganier.

With but one exception, all the medallists and prize winners were in attendance. From the West Coast was J. C. Stevens, the Norman medallist; while from just east of the Rockies came Victor L. Streeter, to receive the Collingwood Prize for Juniors. The Middle West was represented by Eugene A. Hardin, winner of the Thomas Fitch Rowland prize, and by W. W. Horner, one of the recipients of the Rudolph Hering medal. (Mr. Horner's co-medallist, F. L. Flynt, was unable to attend.) From New England came E. C. Harwood, winner of the Arthur M. Wellington prize, and from Pennsylvania, Inge M. Lyse, one of the J. James R. Croes medallists. The remaining prize-winners—Bruce Johnston (co-medallist with Professor Lyse), and Boris A. Bakhmeteff and Arthur E. Matzke, recipients of the James Laurie prize—were from the New York area.

After the awards there was a brief business meeting, and the session ended with the introduction of the incoming officers.

Almost 400 attended the luncheon in the Engineering Societies Building that preceded the afternoon session. Meanwhile, in the lobby downstairs, the registration desk was busy with late comers, many of whom had been delayed by disrupted train schedules from the West.

The general meeting on Wednesday afternoon was a symposium on the proposal for establishing a national department of public works. The opening paper, by Alonzo J. Hammond, traced the history of the movement to establish such a department. Next

George W. Burpee outlined the arguments in favor of the proposal, and in concluding the formal program, Donald H. Sawyer stressed the practical objections to its consummation. The lively arguments that followed brought out wide differences of opinion on the subject, and indicated that an extensive discussion can be expected when the papers appear in print.

During the general session, more than 200 young men gathered on another floor for the Conference of Student Chapters. With a student in the chair, and other students presenting more than half the speeches, the program was run promptly on schedule from beginning to end, and won high praise for its efficient management from many of the older men who "dropped in for a look and stayed to listen."

The headline social event of the Meeting was the formal dinner and dance held on Wednesday evening in the Grand Ball Room of the Waldorf-Astoria. The program included a reception for the incoming President and the Honorary Members.

Technical sessions sponsored by five of the Technical Divisions occupied the entire second day. The Power Division was busy both morning and afternoon with its six-paper program on the cost of power. This symposium was arranged as a logical sequel to that presented at the 1936 Meeting at Pittsburgh on "Economic Aspects of Energy Generation," which was recently published in PROCEEDINGS (December 1937). It laid particular stress on factual data. The opening paper, "Elements of Power Cost," by John C. Page, struck the keynote by asking for a calm consideration of the question and proposing that engineers take the lead in solving the problems involved. The next paper, by C. F. Herschfeld and R. M. Van Duzer, went into great detail in analyzing the factors in the cost of heat-generated energy. The authors warned against generalities in cost studies, and pointed out the necessity of modifying the data they presented to make it conform to the actual conditions at any given plant. Cost of hydro-generated energy was next discussed somewhat similarly by H. K. Barrows, who stressed the fact that hydro is of greatest importance as a source of power complementary to steam. He said that there still remain many hydro sites feasible for commerical development as the power market grows.

At the afternoon session, the cost of combined energy generation was discussed in detail by Ezra B. Whiteman; Maurice R. Scharff took up the factors of depreciation and obsolescence; and W. F. Uhl closed the symposium with a presentation of additional data on power costs and a summarization of the data and the viewpoints of the preceding speakers.

The Structural Division opened its morning session with a paper by W. M. Wilson describing fatigue tests of actual fabricated structural members performed at the University of Illinois. These full-size tests have opened up a wide field of research, and are of special interest in view of Professor Wilson's conclusion that tests of small machined-and-polished specimens have no value in determining the fatigue strength of riveted structural members. Hardy Cross next presented the progress report of the Committee on Masonry and Reinforced Concrete, and the final feature of the morning program was a brief summary of a comprehensive paper by Harold E. Wessman on the preliminary design of suspension bridges. The nature of this paper precluded its oral presentation in full.

In the afternoon, the structural engineers returned for a briefer meeting, at which Wilbur J. Watson discussed the application of architectural principles to bridges. Mr. Watson pointed out that Vitruvius' six fundamental principles of architecture, enunciated two thousand years ago, were still valid, and proceeded to interpret them in modern terms.

The third group with a double-session schedule was the Sanitary Engineering Division. Progress reports were presented in the morning meeting by Thomas H. Wiggin (for the Committee on Water Supply Engineering) and Harrison P. Eddy, Jr. (for the Committee on Technical Aspects of Refuse Disposal). Of interest also was the general discussion of the Vinson Bill and other proposed legislation affecting the control of stream pollution.

Opening the afternoon meeting, Earle B. Phelps presented a general survey of the field of air sanitation, covering both its history and its present status. Next J. J. Bloomfield discussed the sanitary engineering aspects of industrial hygiene—that is, those phases concerned with the study and improvement of working environment. Both speakers stressed the need for sanitary engineers in the industrial field to familiarize themselves with physiology, bacteriology, bio-chemistry, and similar subjects.

1937 Board of Direction of the Society

Starting at extreme left and proceeding clockwise: Arthur S. Tuttle, Past-President; James L. Ferebee, Director, District 7; Daniel W. Mead, Past-President; Ivan C. Crawford, Director, District 12; L. L. Hidinger, Director, District 14; H. S. Morse, Director, District 9; Theodore A. Leisen, Director, District 16; R. P. Davis, Director, District 6; Enoch R. Needles, Director, District 1; Raymond A. Hill, Director, District 11; C. E. Myers, Director, District 4; L. F. Bellinger, Vice-President, Zone II; Herman Stabler, Director, District 5; Thomas E. Stanton, Jr., Director, District 13; William J. Shea, Director, District 1; R. C. Gowdy, Vice-President, Zone III; Arthur W. Dean, Director, District 2; E. P. Arneson, Director, District 15; Otis E. Hovey, Treasurer; Carolina Crook, Secretary to Mr. Seabury; George T. Seabury, Secretary; Edward P. Lupfer, Vice-President, Zone I; T. Keith Legaré, Director, District 10; Carlton S. Proctor, Director, District 1; James K. Finch, Director, District 1; Charles B. Burdick, Director, District 8; and H. W. Dennis, Vice-President, Zone IV.

A single technical session was held in the morning by the City Planning Division. It opened with an exposition by L. W. Segoe of the National Resources Committee's Urbanism Study, with emphasis on the features of special interest to engineers—problems of physical development, congestion, inadequate public facilities, haphazard dispersion, and so forth. There followed a group of three papers presenting, from as many different points of view, the functions of planning commissions in cooperation with public housing authorities. William J. Fox described a contemplated project for the housing of unemployable indigents in Los Angeles County, Calif. It is estimated that the cost of maintaining the 1,000 indigent families in that area could be cut in half by constructing small houses for them to live in instead of paying the rent on their present quarters—and that the environment in such a development would be superior to their present one. Theodore T. McCrosky looked at city planning and housing from the municipal standpoint, and stressed the importance of close liaison between the planning board and the housing authority. The federal authority, he pointed out, would act as banker and counselor, but the responsibility for building housing rests with the municipal authority. Joseph Nevin, in turn, considered the problem from the standpoint of the state housing authority, using conditions in New Jersey by way of specific illustration.

The Highway Division opened its program with a paper by John P. Hogan, telling of plans to take care of vehicular traffic at the New York World's Fair—where an average daily attendance of 250,000, and a maximum day of 800,000 visitors, is anticipated. Progress in road building in Mexico, where an extensive development of the highway system is now under way, was next discussed in a paper by Ricardo L. Vasquez. Earl J. Reeder's paper on traffic problems in metropolitan areas concluded the program. Mr. Reeder emphasized that traffic planning is distinctly an engineering problem, and that the day is long since past for trial-and-error methods of solution.

Back again at the Waldorf-Astoria on Thursday evening, the Society packed the Grand Ball Room to capacity for the annual Smoker. In the early part of the evening Capt. John D. Craig, nationally known for his ability at filming "thrillers" and scientific subjects on the ocean bed and in the jungles and arctic regions, regaled the audience with accounts of his adventures at the bottom of the sea. Later, around the crowded tables, members and their guests had ample opportunity to visit with old friends and new acquaintances from far and near.

An innovation this year was the presence of the ladies at the evening entertainment. They had had their own party in the afternoon—a fashion show and tea at Wanamaker's—but at the Smoker one entire balcony was reserved for their use.

In a flurry of snow flakes on Friday morning, ten well-filled busses pulled away from the Engineering Societies Building for an all-day excursion to points of engineering interest in New Jersey. Outstanding features of this trip were the inspection of the Bendix Aviation Corporation's plant, now building at Bendix, N.J.; the luncheon at the Swiss Chalet at Rochelle Park, and the visit to the Pennsylvania Railroad Terminal improvements at Newark.

By Saturday many of the visitors had already left for their homes, but there was nevertheless an excellent turnout for the four local inspection trips scheduled for that morning. The Sixth Avenue Subway construction attracted a large number of the visiting members, whose interest had been stimulated in the preceding days as they peered into the busy caverns beneath the street on their way to and from Headquarters. Also popular were the Midtown Tunnel inspection, the tour of the West Side park and railroad improvements, and the visit to the site of the coming World's Fair, where construction is in full swing.

On Saturday, also, the Sanitary Engineering Division visited the Wards Island Sewage Treatment plant. The trip was a joint one, with members of the New York State Sewage Works Association also taking part. (The annual meeting of the latter organization was concurrent with that of the Society.)

Thus concluded a most interesting and enjoyable Annual Meeting. Not only in size but in technical volume it set a mark for emulation in the future. In addition to the many who took active part in the proceedings, generous credit should also go to the various committees who arranged the details. While very much in the background, these groups did their work thoroughly and efficiently. The splendid results reflect great credit on all those who shared in the preparation and execution of the excellent arrangements, both technical and social.

A Glance at Society Progress in 1937

Excerpts from the Annual Report of the Board of Direction Give Typical Details

THE YEAR just past saw the Eighty-Fifth Anniversary of the founding of the Society. On November 5, 1852, twelve prominent engineers, living in or near New York City, gathered to form the association which is now the American Society of Civil Engineers.

Their immediate objective was the exchange of information on engineering theories and practices. That objective is still the primary function of the Society, but with an increase in membership to more than 15,000, resident all over the world, and with the changes incident to the passage of time, the Society is now much more than a debating forum. Rather, it is a source of information and an educational agency on all matters relating to the civil engineering profession.

The Board of Direction has at its disposal committees of selected members skilled in many matters, ranging, on the one hand, from the very practical question of the salary situation and the development of a greater appreciation by the public, to the formulation, on the other hand, of sound conclusions with respect to highly theoretical problems and economic procedures and practices of great public concern.

In lesser details the staff of the Society acts as a clearing house for the assemblage and distribution of data on many subjects, and through the Local Sections there has been the endeavor to bring home directly to every member of the Society, resident wherever he may be, some measure of that which he most needs or desires in the practice of his profession.

* * * *

The Society closes the year 1937 with the largest recorded membership of all time—15,459. An important detail is that the increase is proportionately larger among the younger men. Juniors a decade ago, that is, at the end of 1927, constituted 11.9 per cent of the Society's membership; today, 23.3 per cent are Juniors.

The studies of the salary question by one of the Society's committees constitute definite recognition of the problems, more particularly those of the younger men. Salary scales have fluctuated widely in many instances in these past few years and although it has been extremely difficult to arrive at helpful conclusions that are capable of factual support, the effort to do so has been constant, and upon more than one occasion definite pronouncements, locally or nationally, have proved both practicable and effective. This is but one instance of trying to make the Society fit the needs of its members.

A basic principle established by the Society's founders was that membership should be accorded to only those persons showing personal technical efficiency and high professional characteristics. There has been no let down in these two fundamental requirements.

* * * *

Since 1901 the Society has been interested in the matter of licensing, or registering, civil engineers.

In 1931 the Board of Direction made definite declaration that it approved of the principle of the registration of engineers and urged upon its members to seek as satisfactory laws as possible. The Society sponsored conferences of representatives of as many associations as found themselves interested to discuss periodically wherein the "Recommended Uniform Registration Law," as it was then called, might be modified and improved.

This past year the Society, through its Committee on Registration, called another conference attended by one or more representatives of 17 interested societies or associations. Thus, a 1937 "Model Law" has been developed and promulgated.

* * * *

A proposed program which has occupied much time on the part of the Board of Direction has been that of strengthening the Local Sections. It has been accepted as an axiom that the greatest good for the greatest number can be achieved, in other than technical matters, through the Local Sections.

Legislation as it may affect the profession for good or for ill is a matter that can be observed most effectively locally. Salaries are largely a local matter, although closely related to national attitude and acceptance. Local publicity properly and effectively presented brings about local appreciation. Hence the efforts made by the Board through its Publicity Director to guide local representatives to a better understanding of publicity fundamentals.

* * * *

Publications should not be overlooked. One new feature only is here mentioned. In Civil Engineering this year has been initiated a new department entitled "Something to Think About." By no means is it the intent of the Committee on Publications that the articles in this department shall be platitudinous commentaries on this or that. Rather it is the intent that they shall be constructively thought-provoking even if in setting forth a thesis there may be disclosed unpleasant features. If unpleasant features are inherent in the problem, the very fact of their disclosure should tend toward their amelioration or removal. The quantity of technical material in this year's regular publications is the largest in the history of the Society.

* * * *

A definite advance technically has been the work of the Soil Mechanics and Foundations Division. Authorized only a year ago its committees are at work and, in October, the Division produced a symposium of papers that held the interest of many at the Boston Meeting.

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In 1936, it was decided to designate as Life Members, those Corporate Members of long standing who had supported the Society by their dues for many years as prescribed by the Constitution. It was further decided to prepare and present to them certificates indicating their designation as Life Members and showing the date upon which had been consummated the prescribed provisions. Thus, 932 certificates were prepared, received the Presidential signature, and were distributed.

Many Local Sections availed themselves of the opportunity to make special occasions by having these local members in attendance as a special event and making presentation of the certificates to each of them.

* * * *

The attendance at the Reading Room during the year was 2,299.

Two hundred and sixty-one periodicals are regularly received. Included in this number are many foreign periodicals, also a number of literary magazines and several daily newspapers.

* * * *

There are at present 61 Local Sections. The Hawaii and the West Virginia Sections were approved by the Board of Direction on October 4, 1937, and the Mid-Missouri Section on July 20, 1937.

* * * *

Membership of Technical Divisions

City Planning	1,446
Construction	2,913
Engineering-Economics and Finance	713
Highway	2,229
Irrigation	1,053
Power	950
Sanitary	1,727
Soil Mechanics and Foundations	384
Structural	2,972
Surveying and Mapping	1,165
Waterways	1,014
Total	16,566

* * * *

There are at present 115 Student Chapters, two new ones having been organized in Vermont during 1937. One was at the University of Vermont, the other at Norwich University. The latter reestablished a previous Chapter that had existed from 1922 to 1926.

* * * *

The publications of the Society for 1937 include one volume of Transactions (Volume 102), 10 numbers of Proceedings, 12 numbers of Civil Engineering, a Year Book, and two Manuals of Engineering Practice (Nos. 13 and 14). New editions of Manuals Nos. 8 and 11, of "Aims and Activities," and of the Model Registration Law, were also issued.

Proceedings—In 1937, Proceedings was marked by the issue of a June number and the omission of the August number. The ten numbers of Proceedings for 1937 contained 31 papers by 35 authors, and 5 symposia. Members and others who took part in the preparation of these papers, reports, and the discussions thereon totaled approximately 425.

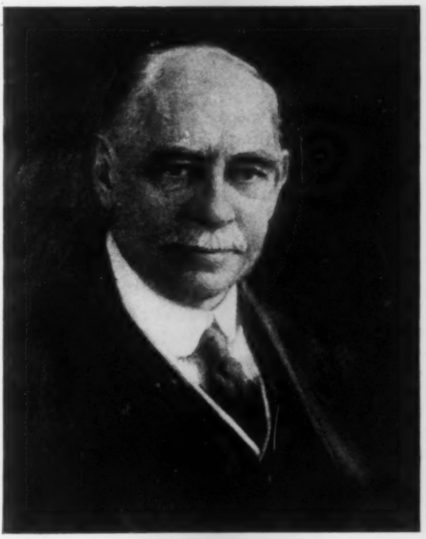
Civil Engineering—Twelve numbers of Civil Engineering were issued for the year. Five of them were given over to abstracts of papers and reports delivered before Society meetings; the remaining seven were regular numbers. Including the space devoted to advertising, this yearly volume of Civil Engineering is the largest to be issued by the Society to date.

Stock of Publications—The stock of the various publications of the Society kept on hand for the convenience of members and others, now amounts to 174,886 copies, the cost of which to the Society for paper and press work only has been $22,133.74, which allowing for depreciation and obsolescence is carried on the books of the Society at a valuation of $11,066.87.

(*The complete annual report will appear in the Year Book number, Part II of the April 1938 "Proceedings."*)

George H. Pegram, 1855–1937

In the brief notice in the January issue, there was opportunity for only a mention of the notable experience of George H. Pegram, Hon. M. Am. Soc. C.E., who died on December 23, 1937. He was long a leader in the engineering profession, and was active up to the time he went to the hospital, only a few weeks before his death. His many friends, who so keenly enjoyed his congenial companionship, will deeply miss this lovable man.



The Late George H. Pegram

The main facts of his engineering experience can be quickly told. This is because, fortunately, he was engaged for so long in a single great activity. He was born beside the Mississippi River in Council Bluffs, Iowa, and graduated from Washington University in St. Louis in 1877. Then followed brief periods of practical engineering work on railways in Idaho and on structural engineering in Chicago and Wilmington, Del. For a short period prior to 1890, he had an office as consulting engineer in New York, N.Y. Next came railroad activities, including five years as chief engineer of the Union Pacific System.

With this splendid training, he was prepared in 1898 to enter upon his long connection with New York rapid transit, first with the Manhattan Elevated Railroad, and after 1905 as chief engineer of the Interborough Rapid Transit Company. In the latter connection his activities included not only operation and maintenance but also engineering direction of an affiliated construction corporation, handling large subway contracts in New York City.

During his long term of service in this work he also gave generously of his time to the affairs of the Society. He was a Director from 1902 to 1904, a Vice-President from 1909 to 1910, and he served as President in 1917. A further honor came to him in 1928, when he was granted the degree of LL.D. from his alma mater. Finally, as one of the greatest tributes to his remarkable success, he was made an Honorary Member of the Society in 1931.

In addition to his fine technical accomplishments, Dr. Pegram will be long remembered for his unusually rich personality. His genius for friendship was manifested particularly in his social activities. At the Engineers' Club he was the acknowledged center of a group that met there for lunch every Saturday. Around a large table many happy hours were spent in banter and merriment. Thus grew up an informal group familiarly known as the "Kitchen

Kabinet," all intensely fond of Dr. Pegram. During his final illness these and others drew up a testimonial of "Birthday Greetings to Brother George," which read in part:

"Among the many fine structures you have built of steel, concrete, and stone, there is none so fine and endearing as that immaterial fabric of friendship with which you have bound us together. Along its space-bridging fibers we send you our sympathy in your present illness, our hope for your speedy recovery, and our love."

He died before this document could be delivered.

A large group of engineers both within and without the Society, some younger and many of his own generation, were happy to enjoy the warmth of his friendship. His was a kindly nature that won and held people by its strength and individuality. One of his intimate friends, who was in a position to speak with authority, has offered the following tribute:

"For forty years it was my inestimable privilege to associate with George Pegram, not only at times in his task of building up a great record of engineering works, but more constantly as an intimate friend. I have thus seen him at close range in action both as an outstanding engineer and as son, brother, husband, father, and friend. In all roles he stood high among the best. He gave much of himself in many ways, and asked little of others. The much he gave spontaneously, wholeheartedly, and joyfully; the little he appreciated and long remembered.

"His great charm lost none of its appeal through all his many years, remaining fresh and youthful to the end—a great blessing to himself and to all who knew him, were they high or low. Ever present in this charm was a keen and unique sense of humor, which enabled him to enjoy the joke on himself just as much as the joke on the other fellow. Wherever he came spirits rose, conversation brightened, and good nature reigned. He was modest, almost diffident, and never indulged in self-assertion however provocative the occasion, but he ever held faithfully and stubbornly to the cause he deemed just. Even when moved to highly expressive anger, as he was at times, he had a most disarming way of quickly soothing the sting of sharp words by some apt and kindly gesture which precluded resentment.

"In his passing, not only his family and intimates are sorely bereft, but the many, with whom he has been thrown in many ways and in many places, will feel the poorer. Yet all should take comfort in the knowledge of his many good works and his eighty-two years of intensive living, in which the spirit of youth and enjoyment remained undiminished to the end."

All members of the profession are the poorer for the death of George H. Pegram. He was the kind of man whose technical attainments and personal character add luster to a great profession.

Society Membership Shows Net Gain for the Year 1937

A NET INCREASE of 2.5 per cent in Society membership during the 12 months ending January 9, 1938, has brought the total membership figure to an all-time high for that date. There are now 15,485 members of all grades, as against 15,115 for the corresponding date of the preceding year, and a previous high of 15,243 for the same date in 1933.

The month-to-month figures published in each issue of CIVIL ENGINEERING are likely to obscure somewhat the long-time membership trend, because of "seasonal" fluctuations. For example, the figures published in October are likely to show a sudden drop of greater or less extent, due to the lapsing of memberships for nonpayment of dues. Later in the year there is a rapid rise, as the applications of the current year's engineering college graduates are acted upon by the Board. Hence a true picture of net change can be obtained only by comparing figures for corresponding dates in successive years, and January 9 is one of the dates least likely to be affected by accidental variations.

Table I suggests that the effects of the depression on membership growth have rather definitely been overcome.

TABLE I. SOCIETY MEMBERSHIP AS OF JANUARY 9

YEAR	TOTAL	YEAR	TOTAL
1931	14,702	1935	14,925
1932	15,199	1936	15,091
1933	15,243	1937	15,115
1934	15,219	1938	15,485

Final Ballot on Society Officers for 1938

33 West 39th Street
New York, N.Y.
January 12, 1938

To the Eighty-Fifth Annual Meeting
American Society of Civil Engineers:

The tellers appointed to canvass the ballot for officers of the Society for 1938 report as follows:

Total number of ballots received		4,544
Deduct:		
Ballots from members in arrears of dues	45	
Ballots not signed	23	
Ballots with illegible signature	3	
Total withheld from canvass		71
Ballots canvassed		4,473
For President		
(Two candidates—one to be elected)		
Henry Earle Riggs	3,671	
David Cushman Coyle	740	
Scattering	1	
Blank	30	
Void	31	
For Vice-Presidents		
Zone I:		
Malcolm Pirnie	4,410	
Scattering	4	
Blank	59	
Zone IV:		
Edward Newton Noyes	4,421	
Scattering	0	
Blank	52	
For Directors		
District 3:		
Arthur William Harrington	4,436	
Scattering	2	
Blank	35	
District 5:		
James Aylor Anderson	4,433	
Scattering	0	
Blank	40	
District 7:		
Louis Evans Ayres	4,439	
Scattering	0	
Blank	34	
District 8:		
Wilford Willis DeBerard	4,435	
Scattering	2	
Blank	36	
District 9:		
Joseph Eugene Root	4,428	
Scattering	8	
Blank	37	
District 12:		
Ross Kerr Tiffany	4,432	
Scattering	2	
Blank	39	
District 16:		
Thomas Radford Agg	4,429	
Scattering	6	
Blank	38	

Respectfully submitted,

DEAN G. EDWARDS, *Chairman*

Charles W. Comstock
Joseph Fertik
Lewis Kuhl, Jr.
Theodore F. Weiss
Thomas K. A. Hendrick
Malcolm S. Spelman
Alexander A. Dedouloff
Medwin Matthews
Frederick C. Lowy
Tellers

The Oldest Local Section?

Last February "Civil Engineering" raised the question as to which Local Section is actually the oldest. Come now three Sections, stating their respective cases in "briefs" that should recall many interesting events of other days. Are there other contenders?

SAN FRANCISCO SECTION

By T. J. Corwin, Jr., *Secretary*

In the latter part of 1904, a number of members of the American Society of Civil Engineers, then living in and around San Francisco, thought it would be a suitable and appropriate move to form a local group for social and professional advancement. There were so many members of the parent society and they were so far away from the center of society activities that such a group offered many advantages. It was felt that meeting one another and discussing subjects of special interest would be worth while.

This idea arose from the fact that the only other organization of its kind in San Francisco, the "Technical Society of the Pacific Coast," which had had a long life of usefulness, was becoming less active as years passed. Some opposition to the plan to form a local group of members of the American Society of Civil Engineers was shown by the Technical Society of the Pacific Coast, which realized that the formation of the new group would probably mean the death of the older local organization.

In the new group there were W. W. Harts (the first president of the Section), Edwin Duryea, Jr., Franklin Riffle, Arthur L. Adams, Charles D. Marx, Luther Wagoner, C. E. Grunsky, C. Derleth, Jr., C. B. Wing, A. M. Hunt, J. D. Galloway, and a number of others.

Inquiry was made of the American Society of Civil Engineers whether such a local group would be recognized and given some standing, for, so far as known, the idea of local groups or branches had never been proposed. It was suggested by the Society that the plan should be tried but without financial help from it. Accordingly a call was sent out for a meeting to discuss the desirability of an organization of this type. Surprising enthusiasm was shown by those who came to the meeting, and the idea was launched.

It was with considerable difficulty that a method was devised for holding meetings without the hiring of a hall. The plan of bi-monthly dinners at different restaurants was adopted, the restaurants to furnish a room after the dinner in which to hold discussions, without additional cost. Expenses were slight and usually came out of the pocket of the president. These meetings grew in interest and became rather elaborate, often with lantern slides and long discussions. Members were not permitted to read papers before their appearance in the Proceedings of the Society but it is no exaggeration to say that the discussions by the local group gave rise to many papers presented before the main society. In the beginning the local organization had no constitution or by-laws but did have a rule that members must be members of some grade in the Society and that the president should have only one term of one year.

Visits to engineering works in the neighborhood were made whenever practicable, such as the Spring Valley water works, power houses, and bridges. As the scope expanded, members increased until there was no longer any doubt of a successful foundation for the organization.

After the first meetings in 1904 in restaurants, and until the earthquake in 1906, meetings were held regularly every two months at the Palace Hotel dining-room. In the year following the fire and earthquake, meetings were held in restaurants on Van Ness Avenue in structures built after the catastrophe. The next move was to the renovated Fairmont Hotel. When the Engineers' Club of San Francisco was formed, that was made the meeting place.

It was in April 1905 that the constitution of the San Francisco Local Section was recorded, some time after the organization was fairly well established, and from this modest early beginning the Sections have grown in size and importance and the whole system of branches has extended over the entire country. The constitution of the San Francisco Section was approved by the Society in 1905.

During the period of the earthquake and fire of 1906, the Local Section offered its services to San Francisco in its problem of rebuilding. These were not accepted but a number of the members were engaged by the city in its work of rebuilding. It had been the hope of many in the group of members that an improvement would be made in city planning before restoration, but the City Council had no broad vision of what an opportunity had thus presented itself for future beautification and convenience.

In 1911 committees of the four national societies were formed to prepare for the proposed International Engineering Congress at the 1915 Panama-Pacific International Exposition. The San Francisco Section of the Society took the lead in this endeavor. The Section contributed greatly to the early formation of the organization which successfully launched the Congress in 1915, and particular credit was due to Messrs. C. D. Marx, A. L. Adams, A. M. Hunt, W . A. Cattell, and Charles Derleth, Jr.

As an agency for encouraging engineers to join the main society, for stimulation of interest in the Proceedings, and for supplying the social and professional needs of local groups, the plan of establishing Local Sections has proved eminently satisfactory.

ST. LOUIS SECTION

By C. D. Purdon, S. Bent Russell, Edward Flad, *and* Edward E. Wall *(Chairman of Committee) Whose Memberships in the Society Date from 1886, 1887, 1888, and 1905, Respectively*

Just as in 1868 a small group of engineers in St. Louis organized the Engineers' Club of St. Louis, which was the third engineering association organized in the United States, so some twenty years later—on February 29, 1888—another group of 16 members of the American Society of Civil Engineers was called together by a written request, signed by Thomas J. Whitman, S. Bent Russell, Henry Flad, Robert Moore, and others. They desired an organization by means of which the St. Louis members of the Society might be called together whenever a discussion of Society affairs was deemed desirable or whenever a local engineering project important enough for debate was under consideration.

Henry Flad was made chairman, Robert Moore, vice-chairman, and S. Bent Russell, secretary, all to hold office indefinitely. Meetings of the St. Louis Association, as this organization was called, were held from time to time, and action was taken on various subjects of interest to the national society; for example, at the meeting held on January 2, 1889, the Association voted that the annual meeting be held at some point in the mountains of Virginia. The convention was actually held in June 1889, at Seabright, N.J.

At the meeting of the Association held in March 1889, the Secretary read "Proposed Amendments to the Constitution of the American Society of Civil Engineers" proposed by the Cincinnati Association of Members of the Society, offered by Robert E. McMath, who received it from Mr. Shinn—probably William Powell Shinn, President of the Society in 1891.

After much discussion, a committee of three was appointed to formulate a reply on the amendments proposed by the Cincinnati Association and also to consider and report on the amendments that had been proposed to the Constitution. M. L. Holman and Robert E. McMath were appointed to act with Robert Moore, the chairman of the Association.

They reported at the next meeting on April 11, 1889, and voted that the first part of the report be adopted and a copy sent to the Cincinnati Association.

At the meeting of the Association on August 5, 1889, the secretary read a communication from Chicago members, including a report on the Cincinnati amendments, and on November 24, 1890, the Association instructed the Secretary to "telegraph to the Cincinnati, Kansas City, Chicago, and St. Paul members its decision on certain members to be elected to office the coming year."

These extracts from the early minutes of the St. Louis Association of Members of the American Society of Civil Engineers are made only to show that this was the first local organization of engineers in the United States composed only of members of the American Society of Civil Engineers, who acted independently on questions affecting the national society, as well as those of merely local interest, although it appears that the Cincinnati members were a close second.

As an illustration of the active interest taken by members of the St. Louis Association in furthering the formation of local organizations of Society members, S. Brent Russell tells the following story:

"Not long after the first meeting of the St. Louis Association, the City of Joliet, Ill., on the recommendation of Thomas J. Whitman, appointed Charles H. Ledlie and myself to make an appraisal of the water works of that city. In the course of our work, the Mayor of Joliet took us to Chicago to consult a prominent attorney in the case. While there, we met Mr. Whitman and other consulting engineers concerned with the case. Mr. Whitman, while in Chicago, undertook to persuade the local engineers to organize an association of members of the American Society, similar to ours in St. Louis. Mr. Whitman, Mr. Ledlie, and myself went to their meeting and found it very interesting. Mr. Whitman's suggestions were adopted, and a local society of Chicago members was organized and officers elected. This Society was kept up for some years, as I remember."

It was not until the twenty-sixth meeting of the St. Louis Association on March 23, 1905, that the question of the proposed formation of a local association of members of the American Society as a chapter of the national society was brought up by M. L. Holman, who submitted correspondence between Charles W. Hunt, Secretary of the Society, and himself. Among these papers was a document giving the views of the Board of Direction on the formation of Local Sections and also a paper giving proposed By-laws for such Sections. After considerable discussion of the question, it was moved by Edward Flad that it would not be desirable at that time to turn the existing St. Louis Association into such an organization as was then proposed.

At the thirty-seventh meeting held on January 17, 1911, Mr. Greensfelder moved that the Committee on Joint Meetings, of which Mr. Woerman was chairman, be continued and instructed to report on the advisability of the Association forming itself into a local chapter of the national society. This motion was carried, but it must have taken much discussion before the Association finally became a Local Section of the American Society of Civil Engineers. The facts, as written in the original minutes of the Association and repeated in this article, undoubtedly show that the St. Louis Association of Members of the American Society of Civil Engineers was the first organization of local members of the American Society of Civil Engineers formed in the United States, but it also indicates that while that is true, it is also true that the San Francisco Association or the Kansas City Association is a candidate for the honor of being the first Local Section of Members of the American Society of Civil Engineers formed in the United States to accept the Constitution and By-laws prepared by the parent society for its Local Sections.

It would seem that the greater honor would belong to the St. Louis engineers because they first conceived the idea and acted upon it some 17 years before it even dawned upon the minds of the Directors of the American Society of Civil Engineers that if an association of its members should be formed in every large city to advise them and inform them of the local sentiment on all subjects of importance to the Society, and to engineers generally, it would greatly enhance its value to the public in general and to the engineering profession in particular.

COLORADO SECTION

By R. E. VAN LIEW, *Formerly Junior Correspondent for the Colorado Section*

STARTING about 1906, the Colorado members of the Society began considering the formation of a state organization of engineers to promote acquaintance among themselves, so that they might better exchange ideas and opinions on technical subjects. They established a local Association of Members of the American Society of Civil Engineers and met weekly around a luncheon table to discuss the problems of those attending. Charles W. Comstock, now living in Jackson Heights, N.Y., recalls: "On these occasions each man talked as long and loudly as he could about his own problems, and became peevish if he was interrupted by others who wanted to talk about theirs."

The idea of forming the Colorado Section developed during a conversation between Charles Warren Hunt, former Secretary of the Society, H. W. Cowan, then chief engineer of the Colorado and Southern Railway Company, and Herbert S. Crocker, Past-President of the Society, at a general conference at the "nineteenth hole" after a game of golf in the spring of 1908.

The main incentive for the organization of the Colorado Section was the Society's fortieth Annual Convention held in Denver in June 1908. This meeting was the first western convention since the one in 1896 in San Francisco. During the meeting a complimentary ball was given to the members and, according to the dance program which, by the way, should be in the records of the State Historical Museum, the boys danced a two-step to the tune of "Put Me Amongst the Girls." Evidently engineers have not changed much in this respect since then.

Mr. Hunt was in Denver to arrange for this convention and was in favor of the plan to form what might be termed a trial organization of this kind, so Colonel Crocker offered to push it with the Colorado members and accordingly, early in November 1908, wrote a circular letter to all the members of the Society in Colorado inviting them to attend a dinner meeting at the Savoy Hotel on November 28, at which the plan was discussed and the details of the organization were defintely determined. The Section was officially organized December 19, 1908, as the Colorado Association of Members of the American Society of Civil Engineers, for the purpose of promoting social and professional contacts among its members and for the furtherance of the aims of the American Society of Civil Engineers.

Since Colonel Crocker had been so extremely active in promoting the organization, he was made president, and with George G. Anderson, vice-president, and Henry J. Burt, secretary-treasurer, formed an executive committee which was made responsible for launching the Section. Those early days were trying ones and if it had not been for the persistence and energy of the members of that first executive committee, the organization would never have been kept alive. It was difficult to explain to many more or less indifferent members of the Society the reasons for the existence of the Section.

The wives of these early members deserve a great amount of credit for their part in furthering the success of the organization. They took turns in entertaining the men at their homes so that the meetings could be held on a more friendly and personal basis. Because of the indirect contact of these women through their husbands they made many lasting friendships among themselves.

The members of this early group were eager to promote the technical interests of the parent Society by the discussion of professional papers, but they were careful to include other features in their program as well. Therefore, they interspersed the professional papers with matters of local engineering interest and parties of one kind or another. This is an old story now and is the common method of conducting the affairs of most of the Sections of the Society, especially where members are few. It must be remembered that since this group was the first real association to be formed, they had to blaze their own way through the virgin forest. Note that I said "real association"; it is true that San Francisco antedated the Colorado Section by a number of years by the forming of an association in 1905, but their objectives were different from those which now obtain. And St. Louis' claim that it predated the Colorado Section may be challenged on similar grounds.

During these early years, the Section was naturally actively interested in developments in the state of Colorado, which have since proved to be outstanding in the history of engineering. Of these, one might mention Houston's Halligan Dam, one of the earliest arched dams; Field's Terrace Dam, one of the earliest hydraulic fills; Ketcham's Alameda Subway, the design of which he thought worth putting into his textbook on *Walls and Bins;* Coy's Laramie-Poudre tunnel, constructed with remarkable speed and creating a record in the United States for one month's progress at a single heading; the Boulder and Shoshone hydroelectric plants, the former one of the highest-head plants in the world at that time, and the latter showing the possibility of long-distance transmission in the mountainous country with altitudes varying from 5,900 to 13,600 ft above sea level. In the Boulder development, the gravity-type concrete Barker Dam was one of the first dams to be designed with expansion joints. When these projects were under construction, water-power development was in its pioneer stage and hydraulic problems, familiar to the modern engineer, had to be solved with little or no empirical data available. In these developments, Messrs. Abbot, Mathews, Ashbaugh, and Jansen, all members of the Society, were actively engaged.

In 1911, the good work of the Committee on Legislation resulted in the bill for the licensing of civil engineers in Colorado, a much-needed piece of legislation.

In 1915, the indefatigable secretary, L. R. Hinman, with humorous notices summoned the gang to their weekly luncheon at Clark's Restaurant, 1632 Champa Street. Shades of Lucullus! Some of the members can still remember the dry hash, spanish stew, and rice pudding for which that restaurant was famous.

The following, from one of Hinman's notices, is worth quoting: "An instrument man in a survey party in Idaho was a very refined young gentleman who was never known to swear. It was his misfortune to be allotted a light transit that had seen too much service. One day he was set up facing the usual Idaho breeze and the transit was trembling as though it had the palsy, when the chief came up behind him and heard him say, 'You are the by-damnedest transit that ever was made. You are no more fit to be called a transit in spite of hell.' "

The photograph of the gang at the Lakewood Country Club in 1915, on the occasion of a luncheon to President Marx and Secretary Hunt, clearly shows what Father Time has done to our members. Some of them, alas, are with us no more, but it is interesting to see Johnnie Field in a high stiff collar looking like a Beau Brummel; Colonel Crocker, as we all remembered him before he took on the World War; and Arthur Ridgway, as he looks today.

Hinman's notice of June 10, 1916, announced that J. B. Lippincott was to speak on the Los Angeles aqueduct and stated that the aqueduct, "will long serve as a remarkable example of municipal enterprise and engineering ability. Boldly conceived to meet a far-seeing vision of municipal growth, boldly and carefully designed to overcome unusual obstacles at a necessary minimum cost" ($24,500,000).

Of interest, too, is Hinman's talk on March 14, 1914, on the sluice gates of Elephant Butte Dam, when he proudly proclaims that the dam "will form the largest artificial body of water in the world, with the exception of Gatun Lake." With the Colorado River aqueduct now under construction and the completion of the Boulder Dam, the young members will find this amusing reading, but they should remember that some of their problems will appear just as elementary twenty years hence.

This article would be incomplete without referring to the talk by W. B. Freeman in September 1916, on "Observations in Siam." On this occasion the members heard for the first time of Bill's intimate relations with the King of Siam, hydrographically speaking, and decided to decorate him with the title of "King" without imposing upon him the strenuous ordeal of a coronation. Long may he reign.

Of the original group of 53 that organized the Colorado Section in 1908, there still remain the following: Fred C. Carstarphen, Herbert S. Crocker, John E. Field, E. C. Jansen, James E. Maloney, and Charles D. Vail.

The actual number of Section members has increased from that 53 to 120. At the present time there are 280 Society members in Colorado, of which 220 are in Denver. About half of the Society members in Colorado are Juniors.

Under the Colorado Section is sponsored the Association of Junior Engineers of the Colorado Section, which held its first meeting on July 17, 1934. The main purpose of this organization is to bring the Juniors together and at the same time to create a greater interest in the Colorado Section and the Society as a whole.

Forecast for February "Proceedings"

Engineering Economics and Public Works

A symposium in which four eminent engineers advocate careful advance planning for public works.

Advantages of Orderly Planning
by Frederic H. Fay, M. Am. Soc. C.E.

Influence of Public Opinion
by Daniel W. Mead, Past-President Am. Soc. C.E.

Hazards of Uneconomical Construction
by Henry E. Riggs, President Am. Soc. C.E.

An Appeal to Reason
by William J. Wilgus, Hon. M. Am. Soc. C.E.

Design of Pile Foundations

by C. P. Vetter, M. Am. Soc. C.E.

A method that takes into account the elastic deformations of the piles.

Flood Routing

by Edward J. Rutter, M. Am. Soc. C.E.; and Quinton B. Graves and Franklin F. Snyder, Juniors Am. Soc. C.E.

Describes a method of flood routing used in TVA studies that is of quite general applicability.

Flood Protection Data

The 1937 report of the Society's Committee recommends a coordination of diverse agencies.

A Chance to Disagree

Full Discussion in Proceedings Is Welcomed

Because of the timeliness and the somewhat controversial aspects of the papers read before the Engineering-Economics and Finance Division of the Society at its Boston Meeting in October 1937, there has been more than the customary interest in their forthcoming publication in the February Proceedings. For this reason it seems proper to restate the relation of the Society to the material published in its Transactions, which is the ultimate goal of papers tested by criticism in Proceedings.

New material may be classified broadly under the two headings—papers and reports. Papers, including symposia and discussions, are independent contributions having no official strength as statements of Society policy. Many of the contributions are by men who are not even members of the Society. Reports are of two kinds—progress reports and final reports; and final reports are of two kinds—those that have been accepted and approved by the Board of Direction and those that have not been so accepted and approved. Note that only the relatively few final reports "accepted and approved" by the Board can, in any way, be cited as the official voice of the Society in contradistinction to its committees. All the great mass of remaining technical material—papers and reports—should be viewed as material under a microscope subject to intense study, research, dissection, and examination—and further revision.

The authors of the symposium, "Engineering Economics and Public Works," are among the foremost in their respective fields, and they speak on this subject with personal authority. They have each served the Society officially and honorably on various occasions throughout their careers. Each of them insists that the ideas expressed are his own and that it is the duty of every engineer, great or small, to enter discussion so that a rational conclusion can be reached and so that false arguments on both sides of this question can be revealed.

The only restrictions upon a full and open discussion of the subject which the Committee on Publications will impose are the standard rules that: The correspondent must confine himself to the scope of the symposium; he must address himself to the authors' data and conclusions and not to his audience; and he may not resort to personalities, either extremely laudatory or derogatory. There is, of course, the added necessity for direct and concise treatment. Those who are interested may wish to refer to a rather complete list of general suggestions for writing effective discussions published in the October 1934 issue of Civil Engineering (page 549), reprints of which will be mailed on request.

Within these broad limits of scope, discussion is "wide open."

Last Call for Discarded Cuts

Those wishing to have cuts from Volume VI of Civil Engineering—that is, 1936—should notify Society Headquarters before March 1, 1938, on which date all cuts from that volume not previously requested will be destroyed. Although requests will be filled in the order in which they are received, preference will be given to the authors of the articles in which the illustrations appear. The only charge will be the cost of forwarding by express or parcel post. Although cuts for the covers and pages of special interest may be borrowed, they must be returned to Society Headquarters.

Local Section Areas Defined

Allocation of Members Becomes Effective by Board Action

FOR THE FIRST TIME the United States has been subdivided by official action of the Board of Direction into Local Section areas, each including the normal zone of influence of the Local Section located in it. All members of the Society, regardless of the grade of membership they may hold, are being allocated to the Section in the area in which they reside without further formality. Just as soon as the lists can be made up at Society Headquarters, each Section's secretary is to be furnished with cards showing the name and address of each member belonging to his Section. Thereafter, every member will habitually receive all communications from his Section and be privileged to attend all its meetings, but unless such a member also subscribes to the constitution and by-laws of a Section, he "shall have no voice nor part in the government of the Section."

The problem of determining just where the common boundaries of the Sections should be located, has been occupying the Committee on Local Sections continuously since early in October, when the Board directed the committee to develop and recommend boundaries which would be mutually agreeable to the Sections. As the result of voluminous correspondence with each Section's officers on behalf of the committee, and by the Sections among themselves, a remarkably high measure of agreement was obtained. Only a few boundaries have required arbitration.

At the meeting of the Board of Direction on January 17, 1938, the recommendations of the committee were considered in detail. The boundaries of the Sections as approved by the Board for the year 1938 are shown in map form as Fig. 1, and are described more definitely in Table I. By reference to the map and table any member can readily determine for himself to which Section he normally belongs. In any event the secretary of his Section should soon be communicating with him.

It is to be noted that state and county lines have been adopted wherever this could be done; and that the entire country, with two exceptions, has been included in Local Section areas. These two exceptions are the state of Wyoming and that part of the state of New York in which Albany is the principal center. In each of these areas the possibility of forming a new Local Section is under active consideration by the members resident there.

Hand in hand with the enlarged membership in Local Sections, goes the possibility of expanding the effectiveness of each Section as a local agency for increasing the usefulness of the Society to its members, to the profession, and to the public which it serves. Increased financial support for Sections has been included in the Society budget, to aid them in carrying out their expanded programs of service.

SUB-SECTIONS NEEDED

As a means of extending Section activities, the committee's report to the Board suggested that in all but a few Sections there is need for the organization of Sub-Sections or Branches in localities where there is sufficient member interest. The committee suggested, further, the desirability for Sections to schedule at least one meeting each year outside the principal metropolitan center in the Section's area.

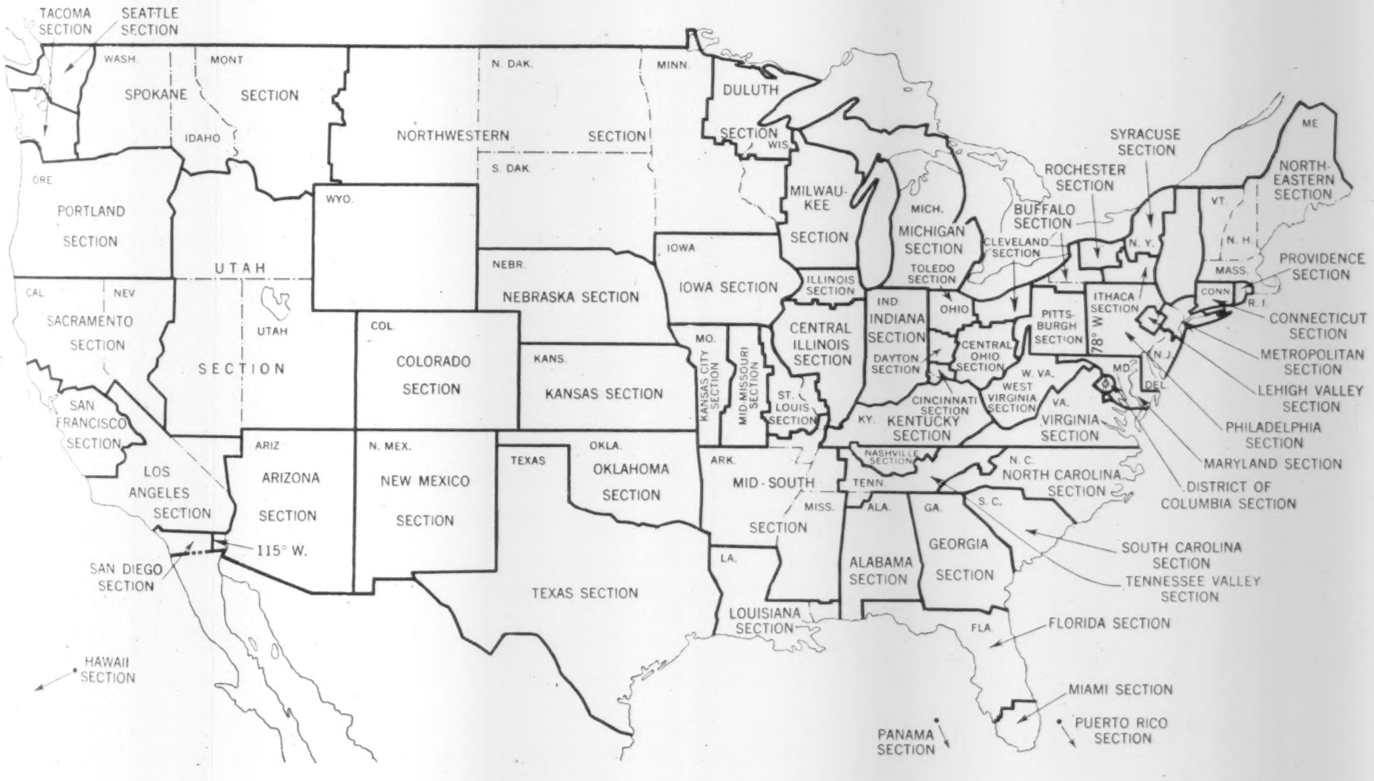
The report also recommended that the officers of the several Sections in states having two or more Sections within their borders organize themselves into a state council as the agency to represent the Society and the civil engineering profession in such state-wide matters as registration, civil service, legislation, fees, and unemployment; and to provide for the effective service of engineers on state matters requiring engineering advice. These purposes can be accomplished by such a state council holding at least one meeting each year for the purpose of discussing accomplishments that are needed, and agreeing on a program to be transmitted back to the Sections for action.

To paraphrase Past-President Tuttle's comments on Local Sections in his Annual Address in 1935: There is no doubt the plan will stimulate the feeling in members belonging to Sections, wherever they may be located, that they are an essential agency of the Society and of the profession as a whole.

TABLE I. LOCAL SECTION BOUNDARIES APPROVED BY BOARD OF DIRECTION JANUARY 17, 1938

SECTION	DESCRIPTION OF AREA
1. Alabama	All Alabama except Lauderdale and Colbert counties
2. Arizona	All Arizona, plus Imperial County, Calif., east of long. 115° W
3. Buffalo	In New York, counties of Niagara, Erie, Cattaraugas, Chautauqua, and Allegany; in Pennsylvania, Erie, Warren, and McKean, plus Potter west of long. 78° W
4. Central Illinois	Illinois south of north lines of Mercer, Knox, Stark, Marshall, Woodfard, Livingston, and Kankakee counties, except river counties of Madison, St. Claire, Monroe, Randolph, Jackson, Union, Alexander, and Pulaski
5. Central Ohio	Ohio east of west lines of Adams, Highland, Fayette, Madison, Union, and Marion counties; south of north lines of Marion, Morrow, Knox, Holmes, Tuscarawas counties; and west of east lines of Tuscarawas, Guernsey, Noble, and Washington
6. Cincinnati	In Ohio, Hamilton, Clermont, and Brown counties; in Kentucky, Boone, Kenton, and Campbell
7. Cleveland	In Ohio, counties of Mahoning, Stark, Wayne, Ashland, Richland, Huron, Erie, Lorain, Medina, Summit, Cuyahoga, Portage, Geauga, Lake, Ashtabula, and Trumbull
8. Colorado	All Colorado
9. Connecticut	All Connecticut
10. Dayton	In Ohio, counties of Butler, Preble, Darke, Mercer, Auglaize, Shelby, Miami, Montgomery, Warren, Clinton, Greene, Clark, Champaign, and Logan
11. District of Columbia	District of Columbia; plus Fairfax and Arlington counties and city of Alexandria, Virginia; plus that part of Montgomery and Prince Georges counties in Maryland within 10-mile radius of zero milestone of District of Columbia, except College Park, Md.
12. Duluth	In Minnesota, counties of Koochiching, Saint Louis, Lake, Cook, Itasca, Cass, Crow Wing, Aitkin, Carlton, and Pine; in Wisconsin, Douglas, Bayfield, Ashland, Burnett, Washburn, and Sawyer
13. Florida	Florida north of northerly lines of Collier, Hendry, and Palm Beach counties
14. Georgia	All Georgia
15. Hawaii	All Territory of Hawaii
16. Illinois	Illinois north of south lines of Rock Island, Henry, Bureau, Putnam, La Salle, Grundy, and Will counties
17. Indiana	All Indiana
18. Iowa	All Iowa
19. Ithaca	In New York, counties of Steuben, Seneca, Schuyler, Chemung, Tioga, Broome, Tompkins, Cortland, and Chenango
20. Kansas City	Missouri west of east lines of Barry, Lawrence, Dade, Cedar, Hickory, Benton, Pettis, Saline, Carrol, Livingston, Grundy, and Mercer counties
21. Kansas State	All Kansas
22. Kentucky	All Kentucky except Boone, Kenton, and Campbell counties
23. Lehigh Valley	In Pennsylvania, counties of Monroe, Carbon, Lehigh, and Northampton; in New Jersey, Warren County
24. Louisiana	All Louisiana; plus Pearl River, Stone, George, Hancock, Harrison, and Jackson counties, Mississippi
25. Los Angeles	In California, counties of Mono, Inyo, Tulare, San Luis Obispo, Kern, San Bernardino, Santa Barbara, Ventura, Los Angeles, Orange, Riverside; in Nevada, Clark County and that part of Nye County south of westerly prolongation of north line of Clark County
26. Maryland	Maryland, except that part of Montgomery and Prince Georges counties within 10-mile radius from zero milestone of District of Columbia, but including to Maryland Section College Park, Md.
27. Metropolitan	Within 50-mile radius from U. S. Post Office, New York City, exclusive of Connecticut; plus Long Island and Westchester counties, N.Y.; and New Jersey north of south line of Hunterdon, Somerset, Middlesex, and Monmouth counties, except Warren County
28. Miami	In Florida, counties of Hendry, Palm Beach, Broward, Dade, Collier, and Monroe
29. Michigan	All Michigan
30. Mid-Missouri	Counties of Putnam, Schuyler, Scotland, Sullivan, Adair, Knox, Linn, Macon, Shelby,

Section	Description of Area
	Chariton, Randolph, Monroe, Howard, Boone, Audrain, Callaway, Cooper, Moniteau, Cole, Osage, Morgan, Miller, Maries, Camden, Pulaski, Phelps, Polk, Dallas, Laclede, Texas, Greene, Webster, Wright, Christian, Douglas, Howell, Stone, Taney, and Ozark, Missouri
31. Mid-South	All Arkansas; all Mississippi except Pearl River, Stone, George, Hancock, Harrison, and Jackson counties; all Tennessee west of west lines of Hardin, Decatur, Benton, and Henry counties; plus Oregon, Ripley, Butler, Stoddard, Dunklin, Pemiscot, New Madrid, and Mississippi counties, Missouri; and Alexander and Pulaski counties, Illinois
32. Milwaukee	All Wisconsin east of west lines of Monroe, Jackson, Clark, Taylor, Price, and Iron counties
33. Nashville	All that part of Tennessee bounded on east and south by east and south lines of Scott, Fentress, Putnam, White, Van Buren, Warren, Cannon, and Rutherford counties, and on south and west by south and west lines of Williamson, Dickson, Houston, and Stewart counties
34. Nebraska	All Nebraska
35. New Mexico	All New Mexico
36. North Carolina	All North Carolina except Madison and Buncombe counties
37. Northeastern	All Massachusetts, Vermont, New Hampshire, and Maine
38. Northwestern	All Minnesota west of east lines of Lake of the Woods, Beltrami, Hubbard, and Wadena counties, and south of north lines of Todd, Morrison, Mille lacs, Kannebac, and Chisago counties; in Wisconsin, counties of Polk, Baron, Rusk, Saint Crois, Dunn, Chippewa, Pierce, Pepin, Eau Claire, Buffalo, Trempeleau, and La Crosse; all North Dakota and South Dakota; all Montana east of west lines of Blaine, Fergus, Wheatland, Sweetgrass, and Carbon counties
39. Oklahoma	All Oklahoma
40. Panama	Republic of Panama and Canal Zone
41. Philadelphia	Pennsylvania east of long. 78° W, except Carbon, Monroe, Lehigh, and Northampton counties; all Delaware; and all New Jersey south of north lines of Ocean, Burlington, and Mercer counties
42. Pittsburgh	All Pennsylvania west of long. 78° W, except Erie, Warren, McKean, and Potter counties; plus Columbiana, Carroll, Harrison, Jefferson, Belmont, and Monroe counties, Ohio
43. Portland	All Oregon
44. Providence	All Rhode Island
45. Puerto Rico	All Puerto Rico
46. Rochester	In New York, counties of Orleans, Genesee, Wyoming, Monroe, Wayne, Livingston, Ontario, and Yates
47. Sacramento	All California north of the southerly lines of Mendocino, Lake, Yolo, Sacramento, Amador, and Alpine counties; plus all of Nevada west of the easterly lines of Humbolt, Pershing, Churchill, Mineral, and Esmeralda counties
48. St. Louis	All Missouri east of west lines of Clark, Lewis, Marion, Ralls, Pike, Montgomery, Gasconade, Crawford, Dent, and Shannon counties, and north of south lines of Shannon, Carter, Wayne, Bollinger, Cape Girardeau, and Scott counties; plus Union, Jackson, Randolph, Monroe, St. Clair, and Madison counties, Illinois
49. San Diego	In California, San Diego County, and Imperial County west of long. 115° W
50. San Francisco	That part of California bounded by the northerly and easterly lines of Sonoma, Napa, Solano, Contra Costa, San Joaquin, and Calaveras counties; the easterly lines of Tuolumne, Mariposa, and Madera counties; and the easterly and southerly lines of Fresno, Kings, and Monterey counties
51. Seattle	In Washington, counties of Jefferson, King, Snohomish, Skagit, Whatcom, San Juan, Clallam, Island, and Kitsap
52. South Carolina	All South Carolina
53. Spokane	All Washington east of west lines of Okanogan, Chelan, Kittitas, Yakima, and Klickitat counties; plus Idaho north of south line of Idaho County; and Montana west of east lines of Hill, Chouteau, Judith Basin, Meagher, and Park counties
54. Syracuse	In New York, counties of St. Lawrence, Jefferson, Lewis, Oswego, Oneida, Madison, Onondaga, and Cayuga
55. Tacoma	All Washington south and west of north and east lines of Grays Harbor, Mason, Pierce, Lewis, and Skamania counties
56. Tennessee Valley	All Tennessee east of westerly lines of Hardin, Decatur, Benton, and Henry counties, and south of northerly lines of Benton, Humphrey, Hickman, Maury, Marshall, Bedford, Coffee, Grundy, Sequatchie, Bledsoe, Cumberland, Morgan, and Campbell counties; plus Madison and Buncombe counties, North Carolina; and Lauderdale and Colbert counties, Alabama
57. Texas	All Texas
58. Toledo	All Ohio north and west of south and east lines of Van Wert, Allen, Hardin, Wyandot, Crawford, Seneca, Sandusky, and Ottawa counties
59. Utah	All Utah; Idaho south of south line of Idaho County; plus Nevada east of west lines of Elko, Lander, and Nye, except Clark County and that part of Nye County lying south of westerly prolongation of north line of Clark County
60. Virginia	All Virginia except Fairfax and Arlington counties and city of Alexandria
61. West Virginia	All West Virginia


TACOMA SECTION
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METROPOLITAN SECTION
LEHIGH VALLEY SECTION
PHILADELPHIA SECTION
MARYLAND SECTION
DISTRICT OF COLUMBIA SECTION
IND.
INDIANA SECTION
OHIO
DAYTON SECTION
CENTRAL OHIO SECTION
CINCINNATI SECTION
PITTS-BURGH SECTION
ITHACA SECTION
78° W.
N. J.
MD.
DEL.
W. VA.
WEST VIRGINIA SECTION
VA.
VIRGINIA SECTION
KY.
KENTUCKY SECTION
NASHVILLE SECTION
TENN.
N. C.
NORTH CAROLINA SECTION
S. C.
SOUTH CAROLINA SECTION
TENNESSEE VALLEY SECTION
ALA.
ALABAMA SECTION
GA.
GEORGIA SECTION
FLA.
FLORIDA SECTION
MIAMI SECTION
PUERTO RICO SECTION
PANAMA SECTION

Fig. 1. Map Showing Local Section Boundaries for 1938

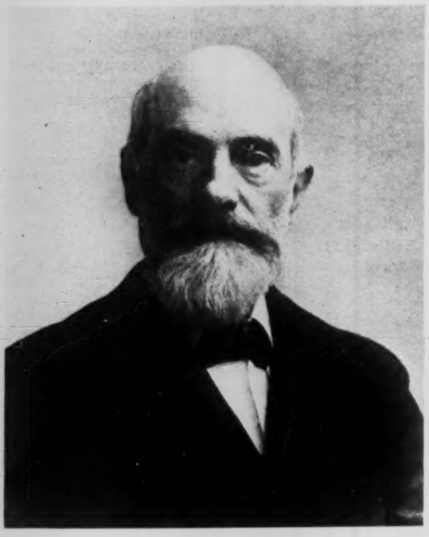
Early Presidents of the Society

XXIII. William Metcalf, 1838–1909

President of the Society, 1893

Readers are urged to keep in mind that their cooperation in supplying photographs, anecdotes, and other data helps to make these sketches readable and informative. The next three articles, for which material is now being assembled, will deal with William Price Craighill, once Chief of Engineers, U. S. Army; George Shattuck Morrison, the famous builder of bridges; and Thomas Curtis Clarke, railroad and consulting engineer.

During the Civil War, one of the principal sources of supply of artillery and projectiles for the Union forces was the Fort Pitt Foundry, at Pittsburgh. In all, more than 3,000 heavy guns were built there, including two 20-in. pieces of 80 tons each, the largest cast-iron artillery there was in the country at that time.



William Metcalf
Twenty-Third President of the Society

In sole charge of the manufacture, as general superintendent of the foundry, was William Metcalf, who had yet to celebrate his twenty-third birthday when the war began. Despite his youth, his record of service in this capacity was so outstanding, one biographer asserts, that his name should stand with those of Abram S. Hewitt and Alexander L. Holley—"perhaps as foremost of the three"—for his contributions to the matériel of the Union armies.

Much of the work was carried on under pressure. On one occasion, for example, thirty 13-in. mortars were manufactured and delivered to General Grant within 40 days of receipt of the order—and were put to effective use immediately to hurl more than a thousand tons of projectiles into the city of Vicksburg. Yet for all the speed and confusion of war-time production, it was Metcalf's modest boast in later years that "not one gun of Fort Pitt make was ever reported as failing in service."

William Metcalf was born in Pittsburgh on September 3, 1838, the son of Orlando Metcalf, a prominent lawyer. He was graduated in 1858 from Rensselaer Polytechnic Institute, and went to work immediately as a draftsman in the Fort Pitt Foundry, whose principal owner was his maternal uncle, Charles Knap.

The peace-time product of the plant was heavy machinery. In the drafting room and on the casting floor, young Metcalf quickly mastered the intricacies of the art, and within a year was promoted to the post of superintendent. Doubtless this rapid rise was not entirely unconnected with his relation to the management; doubtless, too, there was a bit of head-shaking among the older hands when the boss's college-trained nephew stepped into command. But whatever discontent may have arisen at the time, it must certainly have been dispelled in short order, for the war record of the foundry bespeaks a superintendent who was master not only of his trade but of his men.

Shortly after the close of the war, Metcalf entered the firm of Miller, Barr, and Parkin, which later became Miller, Metcalf, and Parkin, and which was incorporated in 1889 as the Crescent Steel Company. This firm specialized in the manufacture of high-grade crucible steel for tools and special uses, and Metcalf was the managing director of the plant.

In those years the slogan of the crucible steel industry might well have been "progress or perish." The Bessemer and open-hearth process plants were each year growing in number and size, and as Metcalf said, "the shadows of these young giants, ever menacing to the expensive and fragile crucible, kept one in a constant state of watching, anxiety, and more study." His answer to competition was research—research along practical lines that kept his firm in the field and made him an authority on the qualities and manufacture of steel.

In that period, says R. W. Raymond (in *Transactions*, American Institute of Mining Engineers, Vol. 41), "the metallurgy of steel was one of our 'burning questions,' and I well remember the position and influence of Mr. Metcalf, as one of the first practical experts to emphasize the importance of mechanical treatment and heat treatment, as compared with chemical composition, and also the different effects of different kinds of tests of strength .... Master of all the practical features of his trade, his shrewd, keen criticisms tempered greatly the zeal of the ardent theorists among us. ... As almost the last of the generation of great steel-makers who made Pittsburgh the Sheffield of America, he discharged a double function, as the rearguard of the old metallurgical practice and the vanguard of the new."

When the Crescent Steel Company became a part of the Crucible Steel Company of America, in 1895, Metcalf sold out his interest and helped to organize the Braeburn Steel Company. Of this firm, producer of high-grade crucible carbon steel and open-hearth steel, he remained as principal stockholder and president until his death in 1909.

In 1896 Metcalf wrote a book—*Steel, a Manual for Steel Users*—that was for some years a standard work on the subject and that was used as a text in several technical schools. The book is long since out of date, and space does not permit a review of its contents. It may be of interest to digress, however, to quote (with malice toward none) two short paragraphs from its introduction. Paraphrased to suit the individual case, they might well be framed and hung over the desk of any author of technical literature:

"The literature of steel has grown with the art; its books are no longer to be counted on the fingers, they are to be weighed in tons.

"Then why write another?"

Metcalf's good and sufficient reason, related in the paragraphs that followed, was "to give to all steel users a systematic, condensed statement of facts that could not be obtained elsewhere, except by traveling through miles of literature"—and he took pains to point out that the book contained no tables, and no detailed data, because "such would be merely a re-compilation of work already done by abler minds."

Because of his special knowledge of the properties of steel and the processes of its manufacture, Metcalf frequently served as expert witness in patent litigation. He was also a member of the board of arbitration that appraised the property of the Monongahela Navigation Company and set the property franchise value of $3,000,000 that was accepted by both the company and the federal government.

Metcalf was active in a number of technical organizations: In 1880 he helped to organize, and was the first president of, the Engineers' Society of Western Pennsylvania; he also read the first paper presented to that society—"Why Does Steel Harden?" In 1881 he was president of the American Institute of Mining Engineers. From 1882 to 1884 he served as vice-president of the American Society of Mechanical Engineers. He was also a member of the American Iron and Steel Association and of the Institution of Civil Engineers (Great Britain).

During his term of office as president of the American Society of Civil Engineers, this organization was host to the civil engineering world at the Columbian Exposition in Chicago. The occasion was the International Engineering Congress, whose civil engineering division was under the Society's direction. Metcalf presided at all the sessions. It is of interest to note that the preparatory work done by the Society included the preprinting of some 1,200 pages of technical papers, gathered from all quarters of the globe. The translations were all prepared by volunteers from the membership of the Society—"men thoroughly conversant with the subjects under consideration."

Metcalf's broad concept of the profession of engineering was expressed in his presidential address, delivered at Chicago in 1893. "Engineering," he said, "is much more than the designing and building of structures, ships, roads, and canals; it involves the economic use of labor on one hand and the proper application of capital on the other; the one must be employed fairly and justly, and the other must be applied so as to yield a reasonable return. . . .

"More than 2,000 years ago a sage wrote that the mechanics are the men who will maintain the state of the world; true then, the statement is equally true today, and the engineer is but the highest development of the mechanic through the evolution of the centuries. . . . He stands as the guide and the arbiter, just to labor on one side and honest to capital on the other. If social questions are out of his province and he may not meddle with them, he may, at least, and he will, be true to his high position and great trusts, and so help to hasten forward that era to which all eyes are turned, the era of 'Peace on earth, good will to men.'"

Metcalf made more than one allusion to peace in this speech and elsewhere, and his attitude toward the subject is of especial interest in view of his work during the Civil War.

"From the time when man was first directed to go forth and subdue the earth, to the present day," he said, "we know that men have always been engaged in gigantic efforts either to destroy one another, to better the condition of the people, or to rear useless monuments to pride and vanity.

"Such efforts continue to this day; but mainly now, we may pride ourselves, they are directed in one way or another for the betterment of mankind, by a reduction of exhausting toil, and by a wider diffusion of comforts."

It was his belief that the increasing frightfulness of weapons of war was all in favor of peace—that armaments were becoming "so destructive and so enormously expensive that the nations are growing afraid of war." Accordingly he referred to the designers of battleships and artillery as "promoters of harmony," and predicted that before the Panama Canal was completed "our military members will have made war altogether too expensive for sensible people to indulge in." In the light of more recent events, it seems that the "military members" may have fallen down on their job.

As for the man himself, it is said that he was one of the most unassuming of men, and that honors and recognitions came to him in spite of himself. "He combined business ability with a love of research and knowledge, but he found time for manifestation of character outside of his chosen field as well." For example, he was one of the founders of the Homeopathic Hospital of Pittsburgh, and its president until his death.

Metcalf died on December 5, 1909. His family consisted of his wife and six children—three sons and three daughters.

"Not one gun of Fort Pitt make was ever reported as failing in service." Raymond, in the memoir already mentioned, quotes those words, and adds, "That sentence, penned by his own hand, seems to me to constitute a comprehensive and appropriate epitaph of its deceased author, who, like the multitudinous productions of his skill and care, never failed in service."

New Year Book Under Way

Work on the publication of the Year Book for 1938 is now going forward, and it is expected that it will appear as Part II of Proceedings on April 15 as usual. The cover of this edition will be blue to distinguish it from its red predecessor of 1937. All changes of title and address must be received at Society Headquarters by March 1 in order to be included.

Each department of the book is being brought up to date, and the pages which are devoted to Local Sections are being increased to admit the inclusion of the names of the president and secretary of the Junior Branches and the Junior Assistants to the Local Section officers. A map of Local Section areas will also be added.

The Annual Report of the Board of Direction, which for many years has been a part of Proceedings, will be published in the Year Book for the first time.

Oregon Student Chapter Features Sunday Breakfasts

Three times each year the members of the Student Chapter at Oregon State Agricultural College fly in the face of American student tradition by turning out almost a hundred strong for a nine-o'clock Sunday breakfast.

These morning meetings, writes Kenneth Lange, the Chapter secretary, have been a continued success, "and the almost unanimous response of the Chapter has thoroughly convinced us of their value. Surely this plan can be used to advantage by other Chapters, and once they get it started they will discover what an asset to Chapter life it can be."

The breakfasts are held at a local restaurant. Each student pays for his own meal, except for a small percentage that is supplied from Chapter funds. The program following the breakfast usually consists of a talk by some outstanding engineer.

Papers Filed in Library

Attention is called to the following papers, which have been contributed to the Society for filing with the Engineering Societies Library, 29 West 39th St., New York, N.Y.. Charges for photostating will be quoted by the latter organization on request.

Lawson, L. M., M. Am. Soc. C.E., "Engineering Work of the International Boundary Commission, United States and Mexico" (40 pages of mimeographed text, plus 26 pages of maps, charts, and graphs). This paper was presented before the Surveying and Mapping Division at the 1937 Spring Meeting of the Society, and was abstracted in Civil Engineering for July 1937 under the title, "Rectification of the Rio Grande." The work of the commission, which includes boundary adjustments, flood control, sanitation, channel rectification, and other related matters, is described.

Hill, Hibbert, Assoc. M. Am. Soc. C.E., "Lateral Resistance of Pile Foundations" (19 pages of typewritten text, plus 5 pages of drawings). This paper discusses the resistance of both vertical and batter piles to lateral loads. Equations are developed which apply to foundations "in which the piles are driven through overburden having negligible supporting value, to a rigid surface, and in which all piles are of the same material and of equal dimensions. Where the piles are seated in more compressible materials, the formulas yield a first approximation which must be modified as well as may be in the light of present knowledge of soil mechanics."

Torpen, B. E., M. Am. Soc. C.E., "Where Rolls the Oregon—An Outline of the Power Possibilities of the Columbia River and Its Tributaries" (62 typewritten pages, including text, maps, tables, diagrams, and photographs). The greatest resource of the Columbia River Valley, says the author of this paper, is the river itself and its tributaries. Though several studies of the power possibilities of the region have been made, "no complete comprehensive plan has yet been presented" for their development. A thorough survey and study is needed of all storage sites in the basin, which "would require several survey parties and a large office force for a period of 5 years." Only then, "can a comprehensive plan be presented with any degree of confidence." This survey, it is suggested, should have the cooperation of the Corps of Engineers, the U. S. Geological Survey, the Bureau of Reclamation, the Federal Power Commission, and the State Engineers of all the states concerned. On the basis of existing data tentative plans are presented for the development of the major streams, involving 60,000,000 acre-ft. of headwater storage and 50,000,000 hp of ultimate generating installation. This storage would eliminate the peak floods on all major tributaries and the main stream, and would automatically provide many benefits to navigation and irrigation.

Appointments of Society Representatives

William G. Atwood, M. Am. Soc. C.E., will represent the Society at the conference of the Australian Institution of Engineers, to be held in Sydney during the week commencing the 28th of March, in connection with the celebration of Australia's 150th anniversary.

Alonzo J. Hammond, Daniel W. Mead, Arthur S. Tuttle, Past-Presidents Am. Soc. C.E.; Henry Earle Riggs, President Am. Soc. C.E.; and George T. Seabury, Secretary Am. Soc. C.E., will serve as Society representatives on American Engineering Council.

William G. Rapp, Assoc. M. Am. Soc. C.E., has been appointed an alternate Society representative on the Sectional Committee for the Preparation of a Safety Code for Cranes, Derricks, and Hoists of the American Standards Association.

News of Local Sections

Scheduled Meetings

Buffalo Section—Luncheon meeting at the Buffalo Athletic Club on Feb. 8, at 12:15 p.m.

Central Ohio Section—Luncheon meeting at the Chittenden Hotel on Feb. 17, at 12 m.

Cleveland Section—Luncheon meeting at the Chamber of Commerce on Feb. 1, at 12:15 p.m.

Colorado Section—Regular meeting on Feb. 14.

Kansas State Section—Annual meeting at Lawrence, Kans., on Feb. 18, at 12:15 p.m.

Los Angeles Section—Dinner meeting at the University Club on Feb. 9, at 6:15 p.m.

Metropolitan Section—Technical meeting in the Engineering Societies Building, New York, on Feb. 16, at 8 p.m.

Nashville Section—Dinner meeting in Kissam Hall at Vanderbilt University on Feb. 1, at 6:30 p.m.

Philadelphia Section—Social meeting at the Engineers Club on Feb. 19, at 6:15 p.m.

Pittsburgh Section—Joint meeting with Engineers Society of Western Pennsylvania at the Mellon Institute of Industrial Research on Feb. 25, at 8 p.m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday (except Feb. 22), at 12:10 p.m.

St. Louis Section—Luncheon meeting at the Mayfair Hotel on Feb. 28, at 12:15 p.m.

San Diego Section—Regular meeting on Feb. 24.

San Francisco Section—Dinner meeting at the Engineers Club on Feb. 15, at 5:30 p.m.

Seattle Section—Dinner meeting at the Engineers Club on Feb. 28, at 6 p.m.

Spokane Section—Luncheon meeting at the Crescent Tea Room on Feb. 11, at 12 m.

Tacoma Section—Dinner meeting at the Walker Hotel on Feb. 14, at 6:30 p.m.

Tennessee Valley Section—Dinner meeting at the University of Tennessee Cafeteria on Feb. 3, at 6:15 p.m.

Texas Section—Luncheon meeting of the Dallas Branch at the Dallas Athletic Club on Feb. 7, at 12:15 p.m.; luncheon meeting of the Fort Worth Branch at the Blackstone Hotel on Feb. 12, at 12 m.

Recent Activities

Central Illinois Section

The November meeting of the Central Illinois Section took place at the Decatur City Club in Decatur on the 18th. Following dinner and a business session, W. D. Hatfield, superintendent of the Decatur sewage disposal plant, presented an instructive paper on the viscosity of sludge. An enthusiastic question-and-answer period followed the presentation of this paper. The Section expressed its appreciation to the Decatur members and to J. A. Gardner, in particular, for arranging such a pleasant meeting. There were 34 present. The same number was also in attendance at the regular annual meeting of the Section, which was held at the Inman Hotel in Champaign on December 16. After dinner W. C. Huntington and J. A. Harman discussed the organization of the Illinois Engineering Council. President Hill then gave certificates of life membership in the Society to J. A. Harman, A. N. Talbot, and E. A. Hermann. After a brief address by President Hill, the Section elected the following officers for the coming year: R. L. Whannel, president; W. C. Huntington, first vice-president; C. M. Hathaway, second vice-president; and R. P. Hoelscher, secretary-treasurer.

Central Ohio Section

President Hill was among the guests present at the annual dinner meeting of the Central Ohio Section, which was held at the Faculty Club on the campus of Ohio State University in Columbus on December 15. The high point of the meeting was the presentation of a certificate of life membership in the Society to F. H. Eno. President Hill made the presentation. The 1938 officers for the Section are R. R. Litehiser, president; R. N. Waid, first vice-president; H. D. Bruning, second vice-president; and R. B. Jennings, secretary-treasurer. There were 60 present.

Cincinnati Section

A joint dinner meeting of the Cincinnati Section and the University of Cincinnati Student Chapter took place at the new Student Union Building on December 6. During the business session several committee reports were read, and recent Society action in so far as it concerns Local Sections was discussed at some length. Certificates of life membership were presented to W. L. Glazier, H. C. Innes, C. S. Millard, and Herman Schneider, and brief remarks were made by Messrs. Glazier and Innes and by J. E. Root, former president of the Section and official nominee for Director of the Society. The speech of the evening was given by Mr. Schneider, who is president of the University of Cincinnati, his topic being basic research in political philosophy. The attendance numbered 36.

Colorado Section

The 1938 officers for the Colorado Section are Roderick L. Downing, president; P. S. Bailey, vice-president; and Roy A. Klein, secretary-treasurer.

On October 25 the Junior Association of the Section held a meeting, which was attended by 44. The program for the occasion consisted of a symposium on the unionization of engineers, the speakers being L. C. Smith, W. F. Swanton, J. S. Hamilton, and W. A. Waldorf. During the ensuing discussion it was established that the idea of unionization was unfavorable to the group as a whole, but it was emphasized that the engineering societies should take an interest in the economic and social welfare of the engineer.

Georgia Section

Election of officers for the coming year was the feature of the meeting of the Georgia Section held on December 13. The list of these new officers is as follows: F. C. Snow, president, and Walter S. McDonald and T. L. Huston, vice-presidents. A. J. Cooper remains secretary-treasurer for another year. During the session a certificate of life membership was presented to C. W. Sturtevant.

Illinois Section

The Illinois Section reports the election of officers for 1938 as follows: J. G. Bennett, president; L. D. Gayton and J. De N. Macomb, vice-presidents; G. B. Massey, secretary; and J. F. Seifried, treasurer.

Ithaca Section

On December 10 the Ithaca Section met with the Steuben Area Chapter of the New York State Society of Professional Engineers for a joint dinner meeting, which was held at the Langwell Hotel in Elmira, N.Y. After dinner an interesting illustrated lecture, entitled "Preparing the Site of the New York's World Fair, 1939," was given by Henry Alden Foster. Mr. Foster, who is acting chief engineer of design for the fair, gave a graphic description of the unusual foundation problems that were encountered. There were 91 members and guests present.

Kansas City (Mo.) Section

There were 37 present at a meeting of the Kansas City (Mo.) Section, held at the University Club on December 14. During the business session the following officers were elected for the ensuing year: J. F. Brown, president; A. B. Taylor, first vice-president; R. N. Bergendoff, second vice-president; and W. M. Spann, secretary-treasurer. The speaker of the evening was Ivan C. Crawford, Director of the Society, who discussed Society affairs of current interest to the membership. Dean Crawford was followed on the program by George F. Gilkison, superintendent of filtration for the Kansas City water works. Mr. Gilkison's subject was the story of how Kansas City changes the silt-laden waters of the Missouri River into the city's water supply.

Kansas State Section

A meeting of the Kansas State Section took place at the Hotel Kansan in Topeka on December 13. After dinner there was a brief business session. Then Ivan C. Crawford, Director of the Society, was introduced. Dean Crawford gave an interesting talk on "Some Water Problems of the Pacific Northwest." There were 23 present.

KENTUCKY SECTION

The annual meeting of the Kentucky Section was held at the Canary Cottage in Louisville on December 13, following the annual dinner. The Section endorsed the proposed bill on the registration of professional engineers, sponsored by the Kentucky Society of Professional Engineers. Then a talk was given by Sam M. Baily, senior engineer in the U. S. Engineer Office, who spoke on flood protection and control. The annual election of officers held at this time resulted as follows: D. V. Terrell, president; A. H. Hinkle, vice-president; and W. W. Sanders, secretary-treasurer.

LOS ANGELES SECTION

On December 8 the annual Ladies Night of the Los Angeles Section took place at the Beverly Hills Hotel. Arrangements for this meeting were in the hands of a committee of ladies, headed by Mrs. Ray L. Derby. Following dinner, the newly elected officers of the Section were presented. These are A. M. Rawn, president; W. W. Hurlbut, and J. W. B. Blackman, vice-presidents; William C. Hogoboom, secretary; and Don H. McCreery, treasurer. A program of readings was enjoyed, and the remainder of the evening was devoted to dancing and bridge. There were 314 present.

METROPOLITAN SECTION

A capacity crowd of over 500 attended the January 12 meeting of the Metropolitan Section, held in the Engineering Societies Building in New York City, to hear an illustrated lecture on structural steel welding by Gilbert D. Fish. Mr. Fish pointed out that the United States leads in the use of welding for building construction, with more than 400 buildings employing that type of design, but that it is far behind Germany in the use of welding for bridges. Further thought, he said, should be given to developments along that line. The American Welding Society was well represented in the audience.

At the January 11 meeting of the Junior Branch, Joseph D. Lewin gave a talk on the subject of grouting with chemicals. He also presented a laboratory demonstration, mixing his chemicals and "consolidating" a number of sand samples in glass tubes. About 60 persons attended.

MID-MISSOURI SECTION

The first technical meeting of the Mid-Missouri Section was held in the Missouri Hotel in Jefferson City on December 3. There were 30 present, a heavy storm being responsible for the small attendance. After dinner there was a brief business session. The first feature of the technical program consisted of a review of recent issues of CIVIL ENGINEERING and PROCEEDINGS, which was presented by Ray Adams. The other scheduled speaker was W. W. Horner, professor of municipal and sanitary engineering at Washington University, whose topic was water resources in the river basins of the state. At the conclusion of his address, Professor Brooks led an open discussion in which the following participated: Henry C. Beckman, Robert B. Brooks, Scott Johnson, and Joe B. Butler.

MILWAUKEE SECTION

Numerous business matters were discussed at the annual meeting of the Milwaukee Section, which took place at the City Club on December 16. The Section believes that the past year has been an unusually successful one and is making plans for another active year. Among other projects the Section is sponsoring a competition for Student Chapter members at Marquette University and the University of Wisconsin, the awards to be given for the best papers on engineering subjects. The Section passed a resolution of bereavement at the death of E. D. Roberts, formerly head of the civil engineering department at Marquette University. The new officers for the Section, elected at this session, are as follows: L. J. Larson, president; J. P. Gebhard, first vice-president; and C. A. R. Distelhorst, second vice-president. F. W. Ullius was reelected secretary-treasurer.

NASHVILLE SECTION

Ten members and four guests of the Nashville Section met for dinner and the regular bimonthly meeting in Kissam Hall at Vanderbilt University on December 7. Several business matters were discussed, and committees appointed. Then F. L. Castleman, Jr., lectured on the subject of the erection of long-span suspension bridges. Mr. Castleman is a member of the staff at Vanderbilt University.

NEW MEXICO SECTION

A joint meeting of the New Mexico Section and the Western Engineers Club of Gallup, N.Mex., took place at Gallup on November 20. The meeting was called to order by Arthur Fife, chief engineer of the Navajo Service, who welcomed the members of the New Mexico Section on behalf of the Western Engineers Club. After luncheon and a business session, papers were presented by Mr. Fife and by C. W. Wright, F. H. Brown, C. H. Powers, and C. J. McCard, all members of the Navajo Service organization. All the papers dealt with some phase of the activities of the Navajo Reservation. The meeting was then adjourned until the next morning when members of the Navajo Service conducted the visitors on a tour of the Navajo Reservation, which is near Gallup. At the annual meeting of the Section, held in Albuquerque on December 20, the following officers were elected for 1938: Robert H. Rupkey, president; Thomas M. McClure, first vice-president; Herbert W. Yeo, second vice-president; and Alan Laflin, secretary-treasurer.

NORTHEASTERN SECTION

Following a dinner at the Harvard Faculty Club, the Northeastern Section of the Society and the Engineering Societies of New England met jointly at Harvard University on December 1. There were about 50 at the dinner, while over 1,000 came in for the lecture afterwards. This was given by Jonathan Jones, chief engineer of fabricated steel construction for the Bethlehem Steel Company. After the illustrated portion of the lecture those who were not interested in the scientific aspects of the work were permitted to leave, and Mr. Jones spent the remainder of the evening answering technical questions.

NORTHWESTERN SECTION

There were 40 members and guests present at a meeting of the Northwestern Section held in the Campus Club at the University of Minnesota on December 11. Numerous business matters were discussed, and a committee on salaries was appointed to cooperate with the Society's Committee on Salaries. A committee to revise the constitution of the Section, as necessary, was also appointed, and a motion pledging all possible help to the State Federation Building Code Committee was carried. The technical program consisted of a talk on water resources planning.

PANAMA SECTION

On December 13 members of the Panama Section met at the Union Club in Panama City for their annual banquet and meeting. Following dinner, R. L. Klotz, assistant to the chief of the Plans Section, Panama Canal, gave a brief résumé of education in the Canal Zone Junior College. Then Allan J. Meadowcroft, instructor in engineering at the college, spoke on the college from the point of view of the faculty. The results of the annual election of officers, reported at this time, are as follows: Glen E. Edgerton, president; E. Lyons, Jr., first vice-president; and E. M. Browder, Jr., second vice-president. Mr. Klotz will continue as secretary-treasurer.

PHILADELPHIA SECTION

Glass as a building material was the topic of discussion on the technical program presented at the December 15th meeting of the Philadelphia Section. The speaker on this occasion was Albert E. Marshall, consulting chemical engineer of New York City, who spoke of the use of glass blocks in building construction and called attention to the efficacy of glass as an insulating material. After tracing the historical development of the art of glass making from earliest times, Mr. Marshall presented lantern slides showing methods of manufacture and examples of the finished product. A special feature of the meeting was the presentation of certificates of life membership in the Society, the presentations being made by Secretary Seabury. Of the 33 members of the Section eligible for this honor, only 19 were able to be present at the meeting. Certificates were mailed to the others. There were 125 at the meeting and 67 at the dinner preceding it. At the conclusion of the meeting refreshments were served and a social hour was enjoyed.

PORTLAND (ORE.) SECTION

The annual dinner meeting of the Portland (Ore.) Section took place on January 7, with 75 present. The secretary's and treasurer's reports for 1937 were read, and officers for the coming year were elected. These are as follows: C. A. Mockmore, president; B. M. Howard, second vice-president; R. E. Cushman, treasurer; and N. H. Leupold, assistant secretary. Officers carried over from last year are R. B. Wright, first vice-president, and F. Kochis, secretary. The technical program consisted of instructive sound motion pictures showing the geologic history of the earth and the development of the airplane.

PROVIDENCE SECTION

An illustrated lecture on the Golden Gate Bridge was the feature of the December 8 meeting of the Providence Section, which was held in conjunction with a session of the Brown University Student Chapter. This was given by Jonathan Jones, chief engineer of fabricated steel construction for the Bethlehem Steel Company. Mr. Jones devoted part of the program to showing a sound motion picture, depicting the actual work of construction. The attendance of 50 included a number of Student Chapter members.

ROCHESTER SECTION

Election of officers for 1938 was the feature of the annual meeting of the Rochester Section, which took place on January 6. These are as follows: William H. Roberts, president; Carey H. Brown, first vice-president; Norman H. Davidson, second vice-president; and Albert R. Reilly, secretary-treasurer. Numerous committees were also appointed at this session. A Section report shows that a number of meetings were held in 1937, some of these being joint sessions with the Rochester Engineering Society. The list of speakers heard at these meetings included R. S. Phillips, of the Portland Cement Association; W. A. Beck and Jonathan Jones, of the Bethlehem Steel Company; C. F. Goodrich, of the American Bridge Company; Gordon F. Dodge, of the Jeffrey Manufacturing Company; Morgan D. Hayes, city engineer of Rochester; Leon R. Brown, of the New York State Railways; and Howard Harding, of the Rochester Gas and Electric Corporation.

SACRAMENTO SECTION

During December the Sacramento Section continued its practice of holding weekly luncheon meetings. On December 7 the 52 members and guests present heard Courtlandt Eaton speak on the engineering and physical aspects of the Holy Land. Mr. Eaton has just returned from a three-month professional trip there. The subject discussed at the meeting held on the 14th was the mechanics and geology of soils as they affect the design of foundations. This was given by Robert V. Labarre, consulting engineer of Los Angeles, and supplemented by a talk on the distribution of soil stresses presented by Trent R. Dames. There were 89 present. The attendance at the December 21 meeting numbered 210, this being the occasion of the annual Christmas festivities. On December 28 the members and guests enjoyed a motion picture entitled "The Story of Creosoted Fir," which was shown through the courtesy of the Charles R. McCormick Lumber Company. There were 37 present.

SAN DIEGO SECTION

A meeting of the San Diego Section took place at the Diner Cafe on November 18, with 14 present. The speaker on this occasion was H. A. Noble, assistant superintendent of the Electrical Production Department of the San Diego Gas and Electric Company. Mr. Noble spoke on the development of electrical generation in San Diego and described recent additions to the San Diego power plant. There were 16 present at the annual meeting of the Section, which was held at the Diner Cafe on December 16. The election of new officers, which took place at this time, resulted as follows: C. B. Neill, president; Paul Beermann, vice-president; and C. Wayland Capwell, secretary-treasurer. A description of the organization and activities of the National Resources Committee completed the evening.

SAN FRANCISCO SECTION

The presentation of certificates of life membership in the Society was the feature of the regular bimonthly meeting of the San Francisco Section, held at the Engineers Club on December 21. Only 19 of the 32 eligible for this honor were able to be present, so certificates were mailed to the others. The technical program consisted of a talk by T. E. Stanton, Jr., materials and research engineer for the California State Division of Highways. His topic was "The Rôle of the Laboratory in the Investigation and Control of Foundations and Materials of Construction." The annual election of officers, held at this time, resulted as follows: R. G. Wadsworth, president; Frederick H. Fowler, first vice-president; Harold B. Hammill, second vice-president; and T. J. Corwin, Jr., secretary-treasurer. The attendance numbered 207.

SOUTH CAROLINA SECTION

There were 16 present at the annual meeting of the South Carolina Section, which took place in Columbia on January 7. Lyle F. Bellinger, Vice-President of the Society, was present on this occasion to give a talk on various Society matters, including finances, the proposed pension system, and the subject of assigning every member to some Section. Mr. Bellinger also presented a certificate of life membership in the Society to E. R. Cary. L. W. Pollard was elected president for the coming year, and A. E. Johnson was reelected secretary.

SPOKANE SECTION

At the annual meeting of the Spokane Section, held at the Crescent Tea Room on December 10, the following officers were elected for 1938: W. L. Malony, president; P. G. Holgren, first vice-president; H. E. Phelps, second vice-president; and E. L. Haines, secretary-treasurer. The principal feature of the evening was a talk on the water resources of the Northwest, given by Arthur J. Turner, chief engineer of the Washington Water Power Company.

TENNESSEE VALLEY SECTION

The Muscle Shoals Sub-Section of the Tennessee Valley Section held a meeting on October 14, which was attended by 14 members and guests. The speaker on this occasion was C. B. Dollins, of the department of operations, Wilson Dam, who discussed geophysical methods of investigating dam foundations. His talk was followed by a round-table discussion on the subject of the unionization of engineers.

On November 4 the Knoxville Sub-Section held a meeting, at which Lyle F. Bellinger, Vice-President of the Society, spoke. A paper was then presented by Stanton Walker, director of engineering for the National Sand and Gravel Association. This paper, which was on the subject of "Trends in Specifications for Concrete Aggregates and Ready-Mixed Concrete," aroused considerable discussion.

The Chattanooga Sub-Section met at the Patton Hotel on November 3, with Vice-President Bellinger as guest of honor. There were 35 present on this occasion to hear Mr. Bellinger discuss Society affairs of interest to the membership.

TEXAS SECTION

A business meeting of the Texas Section was called to order on November 20. At this session a number of committees were appointed for the coming year. The subjects discussed included vocational guidance as a possible Section activity in the high schools and preparatory schools of the state, the place of the spring meeting, Section dues, and the 1938 budget. E. P. Arneson, Director of the Section, reported on the new scheme of allotting members to Local Sections and discussed other Society matters of interest.

TOLEDO SECTION

On December 22 the annual meeting of the Toledo Section took place at the Park Lane Hotel, with 33 present. Following dinner, ballots for the officers for 1938 were counted. These are P. W. McDonnell, president; S. C. McKee, first vice-president; W. H. Hasselbach, second vice-president; and R. W. Abbott, secretary-treasurer. Then C. S. Finkbeiner, consulting engineer of Toledo, presented certificates of life membership in the Society to H. O. Hem, A. H. Smith, and G. A. Gessner, the latter's award being made in absentia. The speaker for the evening was John S. Worley, professor of transportation engineering at the University of Michigan, who discussed modern and future transportation. In this talk Professor Worley gave a résumé of the history of the streamlined train and discussed its part in present-day transportation.

UTAH SECTION

At the annual meeting of the Utah Section, held at the University Club in Salt Lake City on December 17, the following officers were elected for 1938: R. A. Hart, president; T. C. Adams, first vice-president; George D. Clyde, second vice-president; and F. H. Richardson, secretary-treasurer. After dinner O. C. Lockhart, retiring president of the Section, presented certificates of life membership to R. K. Brown and H. S. Kerr. Moving pictures were then shown of the manufacture and placing of the large reinforced concrete pipe for the Colorado River Aqueduct near Ontario, Calif. Another motion picture was also enjoyed. This film, showing the work of the U. S. Army Engineers at the Fourth Army Maneuvers at Fort Lewis during the past summer, was shown and discussed by George A. Taylor, who made the film.

Virginia Section

The fall meeting of the Virginia Section was held at the Patrick Henry Hotel in Roanoke on November 13. After the business meeting the 80 members and guests present heard a fine technical program. Among the speakers appearing on this program were Stanley W. Abbott, resident landscape architect for the National Park Service; H. Norton Stone, erection engineer for the Virginia Bridge Company; Thomas H. Evans, assistant professor of civil engineering at the University of Virginia; W. E. Reynolds, of the U. S. Treasury Department; Harold D. Hussey, designing engineer for the American Bridge Company; and C. D. Spohr and E. H. Fuller, Student Chapter members. After luncheon, which was served in the main dining room of the hotel, E. M. Hastings presented a certificate of life membership in the Society to W. D. Tyler, the only member thus honored who was able to be present. Certificates were mailed to the others. In the afternoon the members visited places of interest around Roanoke. Much of the success of the meeting was due to the efforts of C. W. Ogden, president of the Section, and to the committee composed of F. P. Turner, E. S. Thomas, H. E. Mecredy, and H. N. Stone.

Student Chapter Notes

Case School of Applied Science

With an enrolment of 33, the Case School of Applied Science Student Chapter has now surpassed its record for the past ten years. On the first Thursday of each month, members of the Chapter meet in their new club rooms, recently furnished with the help of the Society. Outside speakers are heard at these sessions. Among those who spoke during the past semester were A. L. Alin, senior engineer of the Pittsburgh Flood Control Project, and H. F. Donner professor of geology at Western Reserve University. From time to time there are other meetings, at which students present the illustrated lectures loaned by the Society. The accompanying photograph shows the members of the Student Chapter.

Members of Case School of Applied Science Student Chapter

Dartmouth College

A meeting of the Dartmouth College Student Chapter was called to order on October 29, with the entire membership present. After the routine business had been disposed of, the Society's illustrated lecture on the Hetch Hetchy water supply and power plant was presented. An enthusiastic discussion followed the showing of these slides.

Texas Technological College

On November 19 the Texas Technological College Student Chapter sponsored an inspection trip to the Conchas Dam project at Conchas Dam, N.Mex. The trip proved to be very successful, despite the fact that it was the first the Student Chapter has ever attempted. About 30 made the trip, and a view of the members at the dam is shown in the accompanying photograph. To facilitate inspection of the project, the students were divided into groups of four and then conducted through the project, the testing laboratories, power plant, water supply system, and employees' living quarters. A luncheon had been arranged by Hans Kramer, district engineer in charge of the construction of the dam, and the entire corps of engineers employed there. After luncheon Captain Kramer and the superintendent spoke, and the outing was concluded with a general discussion.

Texas Technological College Student Chapter and Guests Visit Conchas Dam Project

Tufts College

There were 14 members present at the regular meeting of the Tufts College Student Chapter, which was held in Robinson Hall on December 15. Others in attendance included members of the student branch of the American Society of Mechanical Engineers, who were guests of the Chapter. The feature of the occasion was an illustrated lecture on "Incinerators and Their Use in the Disposal of Garbage and Refuse," which was given by Harrison P. Eddy, Jr., consulting engineer of Boston, Mass.

University of Dayton

At a meeting of the University of Dayton Student Chapter held on December 20, the Society's lantern slides on the Catskill water supply were greatly enjoyed. Some of the slides proved of special interest and were discussed at such length that the meeting ran well over the scheduled hour. Several business matters were also discussed at this session.

University of Maryland

Recently the University of Maryland Student Chapter devoted a special session to the showing of the Society's illustrated lecture on aerial photographic mapping. On this occasion the lecture was read by John R. Browning, a member of the Chapter.

University of Pittsburgh

On December 16 a regular meeting of the University of Pittsburgh was called to order by William J. Szawzuk, vice-president of the Chapter. Lantern slides on the "Recent Power Development at Niagara Falls" were presented through the courtesy of the Society. The accompanying lecture was read by the secretary of the Chapter, while the slides were shown by V. A. Faller, a member of the Chapter.

Utah State Agricultural College

The Society's lantern-slide lecture on aerial photographic mapping was presented at a meeting of the Utah State Agricultural College Student Chapter, which took place on November 23. The lecture was read by A. L. Christenson, of the geology department of the College. The 75 students present found the lecture very stimulating.

ITEMS OF INTEREST

Engineering Events in Brief

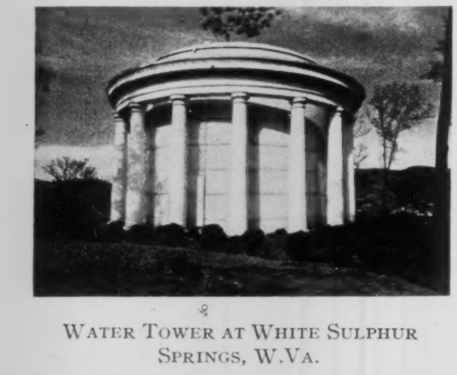
Civil Engineering for March

Over a score of interesting papers, together with a number of committee reports, are being presented at the Eighty-Fifth Annual Meeting of the Society, in progress at the time this issue of Civil Engineering goes to press. These papers include a symposium on the proposed national department of public works and another on the cost of power, and cover in addition such topics as air sanitation and industrial hygiene, engineering and architectural aspects of bridge design, aspects of the National Resources Committee's urbanism study, and highway development in American metropolitan areas and in Mexico.

As complete a treatment will be accorded each paper as space limitations will permit. It is possible that some of the papers and reports will be eligible for publication in full in Proceedings at a later date, and in such cases comparatively brief attention will be given them in Civil Engineering. The disposition of each, however, will be determined through study by the Committee on Publications. In both publications an effort will be made to convey to all members a full measure of the inspiration experienced by those attending the Annual Meeting.

A Temple to the Gods

Like the ancient Greeks, man still builds his temples to the gods of nature. This month's frontispiece and the accompanying photograph depict an interesting and sightly water tank 60 ft in diameter and 48 ft high with a capacity of a million gallons. This subject has been suggested by its designer, Reginald H. Patterson, Assoc. M. Am. Soc. C.E., for use in the series illustrating "Art in Engineering" which has been featured in preceding issues and has included several well-designed water towers.



Water Tower at White Sulphur Springs, W.Va.

Colonnade and Cornice Stand Free of Tank

With its 16-column colonnade and its interesting cornice of concrete and stucco, this structure gives a temple-like appearance. The site is rural, rather than urban as in the examples previously portrayed. Yet in this as in the former cases, the structure seems to fit naturally into its setting. This adaptation of form to function and location illustrates graphically how engineers today can combine the beauty of ancient edifices with the usefulness of modern structures. This water tank was built for White Sulphur Springs, Inc., at White Sulphur Springs, W. Va.

Washington Award to Go to Frank Baldwin Jewett

The Washington Award for 1938 will go to Dr. Frank Baldwin Jewett, vice-president of the American Telephone and Telegraph Company and president of the Bell Telephone Laboratories, Inc., according to a recent announcement by the Western Society of Engineers. This award is made annually—providing the members of the award commission agree on a deserving candidate—as an honor conferred on a brother engineer by his fellows for accomplishments which preeminently promote the happiness, comfort, and well-being of humanity. Its tangible symbol is a bronze plaque mounted in marble.

As Dr. Jewett left the United States in January and is not expected to return until about the middle of March, the award commission has decided to postpone the presentation ceremonies, usually held in February, until some time in April or May. Dr. Jewett, a past-president and fellow of the American Institute of Electrical Engineers, is the fifteenth noted American engineer to receive this award since it was founded in 1915 by John W. Alvord of Chicago. Nine are past or present members of the Society.

The Washington Award is administered by the Western Society of Engineers in cooperation with the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers.

Wise and Otherwise

During the past autumn, Professor Abercrombie had occasion to try out a couple of fast horses, one a pacer, on his 600-ft circular track. His single assistant, a boy, was secure only on the pacer and was not familiar with a stop-watch, so it fell to the lot of the Professor both to ride the other horse and to operate the watch. In view of this situation, and with his fondness for the unusual, Professor Abercrombie voiced an intention to time both horses concurrently.

They lined up at the barrier, and at his shouted "proceed" (the Professor avoids "giddap" as ungrammatical) they were off. The Professor's horse took the lead immediately, and 30 seconds after the start had covered one complete lap more than the pacer. Reining the horses to a walk, they returned to the starting point. Once more they started, this time in opposite directions. As they flashed by each other ten seconds later, the Professor pulled down his horse and announced that the workout was over. On the way to the stables, the boy asked whether sufficient information was available to time both horses. Professor Abercrombie replied in the affirmative, and added that only a very simple computation was required. How can this be done?

January's problem involved a 50-lb block of ice floating in a trough brim-full of water. Three questions were asked. What part of the ice's weight is carried by the left support when the ice is directly above it? What part when the ice is directly above the right support? What will happen to the water in the trough when the ice melts?

The answers to the first two questions are identical: One-half the weight of the ice, or 25 lb (since the surface of the water is at the same height at all points). When the ice melts (neglecting evaporation) the water will remain exactly at the brim of the trough, since a floating body displaces its own weight of water and expansion in freezing is equal to contraction in melting.

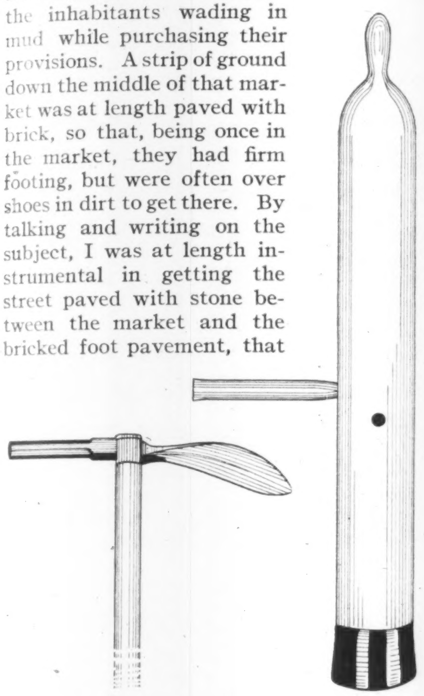
Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

Some Early Types of Paving in Philadelphia

It is difficult for the modern highway engineer to picture conditions in our cities in the early days, when streets were either all dust or all mud, depending upon the weather, with a narrow footwalk at most. The following account of early paving in Philadelphia is taken from material furnished by C. E. Myers, M. Am. Soc. C.E., consisting of a paper entitled "Bits of Philadelphia's Highway History," by Dudley T. Corning, M. Am. Soc. C.E.; and another called "River Boulders or Cobblestones Used for Paving," by James H. Fitzgerald, of Mechanics Valley, Pa.

In Philadelphia, foot pavements and crossing places in the mid streets were laid as early as 1719, according to an early letter, while the first public paving was done prior to 1750. Benjamin Franklin, in his autobiography, is quoted as follows:

"Our city, though laid out with a beautiful regularity, the streets large, straight, and crossing each other at right angles, had the disgrace of suffering those streets to remain long unpaved, and in wet weather the wheels of heavy carriages ploughed them into a quagmire, so that it was difficult to cross them; and in dry weather the dust was offensive. I had lived near what was called the Jersey Market, and saw with pain the inhabitants wading in mud while purchasing their provisions. A strip of ground down the middle of that market was at length paved with brick, so that, being once in the market, they had firm footing, but were often over shoes in dirt to get there. By talking and writing on the subject, I was at length instrumental in getting the street paved with stone between the market and the bricked foot pavement, that was on each side next to the houses. This, for some time, gave an easy access to the market dry-shod; but the rest of the street not being paved, whenever a carriage came out of the mud upon this pavement, it shook off and left its dirt upon it, and it was soon covered with mire, which was not removed, the city as yet having no scavengers.


Cobblestone Hammer

Cobblestone Rammer

Fig. 1. Tools Used in Placing Cobbles for Paving

"After some time I drew a bill for paving the city, and brought it into the Assembly. It was just before I went to England in 1757, and did not pass till I was gone, and then with an alteration in the mode of assessment, which I thought not for the better, but with an additional provision for lighting as well as paving the streets, which was a great improvement. It was by a private person, the late Mr. John Clifton, his giving a sample of the utility of lamps, by placing one at his door, that the people were first impressed with the idea of enlightening all the city. The honor of this public benefit has also been ascribed to me, but it belongs truly to that gentleman. I did but follow his example, and have only some merit to claim respecting the form of our lamps, as differing from the globe lamps we were at first supplied with from London. Those we found inconvenient in these respects: they admitted no air below; the smoke, therefore, did not readily go out above, but circulated in the globe, lodged on its inside, and soon obstructed the light they were intended to afford; giving, besides, the daily trouble of wiping them clean; and an accidental stroke on one of them would demolish it and render it totally useless. I therefore, suggested the composing them of four flat panes, with a long funnel above to draw up the smoke, and crevices admitting air below, to facilitate the ascent of the smoke; by this means they were kept clean, and did not grow dark in a few hours, as the London lamps do, but continued bright till morning, and an accidental stroke would generally break but a single pane, easily repaired."

Little information is available relative to any paving immediately following the Revolution, says Mr. Corning, until it is recorded, about 1830, that the excellent condition of both the cartway and footway paving appeared to have given the city a note of distinction. Cobbles, previously called "pebbles," were still the prevailing material for cartway paving. They were placed by the use of special tools, two of which are shown in Fig. 1. In this connection, Mr. Fitzgerald writes:

"Before proceeding to pave a street with cobblestones it was graded and given a coat of gravel or ashes to a depth of several inches. The paver placed the cobblestones on end, using a tool with a short handle resembling a pick with a poll. When necessary, some of the gravel was picked from the bed in placing the larger stone, so that the surface would be even. The paver gave the stone a sharp rap with the poll end of the tool. A generous quantity of gravel or sand was spread and raked over this surface in order to fill the interstices. The cobblestones were then rammed tight into place. The tool used was of oak or hickory, about $4^1/_2$ ft in height and from 4 to 6 in. in diameter, with an iron band near the bottom. There were two handles. One was inserted at a point near the center at right angle; the other was on the top and vertical. The standard weight of this tool was 55 lb."

The cobbles or "pebbles" were gathered in shallow water from the bed of the Delaware River and nearby streams. In describing this activity, Mr. Fitzgerald says:

"During the summer months, when the river was low and the water warm, flat boats from 12 to 18 ft in length were anchored in shoal water. The pickers stood on the river bottom, and using a long-handled fork, made for the purpose, tossed the cobbles into the boat. A grapple was sometimes used, especially when the stones were heavy. When the boat was laden it was propelled with the use of poles to the shore and unloaded. 'Boothers,' meaning boulders, was a local name given to these cobblestones. On bills-of-lading, however, they were called 'pavers.'... A drag or 'boother rake' with 12 teeth or prongs was used to drag the cobblestones from deep to shallow water. . . . From the banks of the river the cobblestones were hauled to the canal bank on carts and wagons, where they were loaded on canal boats."

Other types of paving were introduced at long intervals. An ordinance approved in 1854, says Mr. Corning, stipulated a new type of paving—dressed stone, and another ordinance in 1868 stipulated the use, on the central city streets, of approved cubical blocks of specified dimensions to be placed upon a bed of clean anthracite coal ashes, gravel, or sand. The first record of asphalt paving is in 1873, when Trinidad Lake asphalt was used. The records show that granite block paving was laid in 1874. The oldest record of an existing vitrified block pavement is of one laid in 1895. Wood block was first laid in Philadelphia in 1909.

Dr. Bowie Honored by Queen of the Netherlands

Her Majesty, the Queen of the Netherlands, has appointed William Bowie, M. Am. Soc. C.E., retired Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey of the Commerce Department, an officer of the Order of Orange-Nassau and has presented to him, through the Minister of the Netherlands, the medallion and diploma of the order.

This honor was bestowed upon Dr. Bowie in recognition of outstanding achievements in the interests of international science and geodesy, and his collaboration with Dr. F. A. Vening Meinesz, professor of geodesy at the University of Utrecht, the Netherlands, and a member of the Netherlands Geodetic Commission, in the determination of gravity-at-sea. The two men have worked together many years in the International Association of Geodesy, a branch of the International Geodetic and Geophysical Union. Dr. Bowie was president of that association from 1919, when it was created, until 1933, when he became president of the International Geodetic and Geophysical Union, and he was succeeded in his former office by Dr. Meinesz.

It was largely through this association that Dr. Bowie became interested in the work of Dr. Meinesz, who had devised and constructed an apparatus by means of which accurate determinations of the values of gravity can be made aboard a submarine. Dr. Bowie was twice instrumental in bringing Dr. Meinesz to the United States to head expeditions for the determination of gravity-at-sea on submarines of the U. S. Navy operating in West Indian waters.

Brief Notes from Here and There

The Federal Power Commission has just released its seventeenth Annual Report, covering activities of the fiscal year ending June 30, 1937, and additional activities to December 1937. "The Commission is proceeding vigorously," according to the report, "to end long-standing abuses [in the field of electrical utilities] and compel compliance with the law." At the same time it has steadily pursued its work in granting preliminary permits and licenses, determining the original legitimate cost of projects, compiling rate and production data, and studying power resources and demands. The report is on sale by the Superintendent of Documents, Washington, D.C., at 10 cents a copy.

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A NUMBER of the larger engineering societies of Great Britain are cooperating as sponsors of an International Engineering Congress to be held at Glasgow, Scotland, June 21–24, 1938. An invitation is extended to all interested members to attend. The program includes visits to the Empire Exhibition (which opens at Glasgow in May), technical sessions, inspection trips, and excursions. Details can be secured from the General Secretariat of the Congress, 39 Elmbank Crescent, Glasgow, C. 2.

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A BILL that would permit state agencies and local legislative bodies to employ independent engineers to check plans for public improvements has again been introduced in the New York Legislature by State Senator T. C. Desmond, M. Am. Soc. C.E. The Public Projects Efficiency bill, as it is called, was presented first in 1936 and again in 1937, but failed of passage. It would permit independent engineers to be retained, whenever a public project is contemplated by the state or any of its subdivisions, to report on such matters as feasibility, extent of public benefit, suitability of site, desirable changes in plans, and cost of a recommended substitute. The recommendations would not be binding, but would be made public in newspapers of general circulation.

NEWS OF ENGINEERS

Personal Items About Society Members

Joseph D. Blatt has resigned as assistant engineer for David M. Oltarsh, Inc., of New York City, to become junior civil engineer for the Bureau of Air Commerce at Atlanta, Ga., where he will superintend the construction of radio directive beacons and intermediate landing fields.

A. P. Gardiner has accepted employment in the bridge designing division of the Washington State Highway Department. He was previously a junior engineer in the U. S. Bureau of Reclamation at Denver, Colo.

William C. Gibson, formerly with the Allegan County (Michigan) Health Department, has accepted a position as sanitary engineer for the W. K. Kellogg Foundation and Hillside County Health Department, Hillsdale, Mich.

Lincoln Ellsworth was awarded a special gold Congressional medal on December 16, 1937, in recognition of his Antarctic flight in 1935, during which he claimed 350,000 square miles of territory on behalf of the United States. Commander Ellsworth was cited by the act awarding the medal as having claimed for this country land "representing the last unclaimed territory in the world," and as having rendered "exceptionally meritorious services to science and aeronautics." The presentation was made by President Roosevelt in the White House. Commander Ellsworth has been the recipient of numerous medals and awards bestowed by scientific societies in this country and abroad. The accompanying photograph is reproduced through the courtesy of the American Museum of Natural History, of which Commander Ellsworth is a trustee.

LINCOLN ELLSWORTH

Alfred Rheinstein, president of the Rheinstein Construction Company of New York City, has been appointed by Mayor La Guardia to the new post as Commissioner of Housing and Building on the New York City Housing Authority.

Elmer E. Barnard, consulting engineer, is now located at 403–404 Lynch Building, Lynchburg, Va. He has confined his practice to the field of sanitary engineering, specializing in water supply, water purification, sewerage, and sewage treatment.

Carl W. Mengel is now director of public works for the city of Greensboro, N.C.

Joseph A. Kestner, Jr., until recently with Burr M. Stark, of Troy, N.Y., has accepted a connection with the New York Power and Light Corporation at Albany, N.Y.

Howard S. Reed has been appointed Arizona state highway engineer, succeeding the late **Thomas S. O'Conhell**. Mr. Reed was previously state engineer for the PWA at Phoenix, Ariz.

E. A. Frink, for many years engineer of bridges for the Seaboard Air Line Railway System, retired from active duty with the company on January 1. Mr. Frink was in charge of the bridges and steel structures of the company from 1906 until his retirement.

Carter Jenkins, formerly assistant regional officer for the National Park Service, U. S. Department of the Interior, has been appointed chief engineer of the Division of Waterways, Illinois Department of Public Works and Buildings, with headquarters in Chicago, Ill. He succeeds **Walter M. Smith**, who retires as chief engineer of the Illinois Division of Waterways but will remain with the Division as consulting engineer and in charge of maintenance operations, with headquarters at Joliet, Ill.

William Glenn Sloan, who is in the Denver office of the U. S. Bureau of Reclamation, has been appointed engineer in charge of a survey of the proposed Cabinet Gorge dam project on the Clark Fork River of Idaho.

Arthur S. Tuttle and **Leslie G. Holleran** have been named consulting engineers to the WPA in New York City to draft a long-range program for WPA construction projects for the city. Mr. Tuttle formerly served as state (New York) director of the PWA, while Mr. Holleran was until recently chief engineer of the PWA.

S. S. Steinberg, head of the department of civil engineering at the University of Maryland, has been named dean, succeeding **A. N. Johnson** who has been retired by operation of the new state retirement act. Professor Steinberg has been serving as acting dean.

Walter A. Shaw, consulting engineer of Chicago, Ill., has been appointed adviser to the District Court of the United States for the Northern District of Illinois, Eastern Division, in reorganization proceedings involving the Chicago Rapid Transit Company, the Chicago City Railways Company, and the Chicago City Railway Company. His duties will include advising the Court on all engineering and operating matters involved in such proceedings.

Albert Reichmann recently retired from the American Bridge Company, having reached the U. S. Steel Corporation retirement age. Mr. Reichmann has been connected with the American Bridge Company since it was organized in 1901, and during this long period of service he supervised the design of many of the largest steel structures in the country. In 1935 he was made vice-president.

James E. Gibbons, consulting engineer of New York City, has become associated with the American Surety Company of New York and the New York Casualty Company, where he will assist in the production, underwriting, and settlement of claims on contract bonds issued by these companies.

Harry Lloyd Nelson has been appointed Eastern sales manager for the U. S. Pipe and Foundry Company, with headquarters in the Lincoln-Liberty Building, Philadelphia, Pa. Mr. Nelson was previously Western research engineer and Pittsburgh sales agent for the same company, with offices in Pittsburgh, Pa.

Gano Dunn, president for twenty-four years of the J. G. White Engineering

Corporation and the author of more than thirty inventions in the design and construction of electrical machinery, has been awarded the 1937 Thomas A. Edison Medal of the American Institute of Electrical Engineers. This medal, which is given annually for "meritorious achievement in electrical science, electrical engineering, or the electrical arts," was presented to Mr. Dunn on January 26 at the time of the winter convention of the Institute.

Gano Dunn

James P. Growdon, formerly assistant chief hydraulic engineer for the Aluminum Company of America, Pittsburgh, Pa., has been promoted to the position of chief hydraulic engineer. He succeeds James W. Rickey who has resigned after thirty years of service in the capacity of chief hydraulic engineer. Mr. Rickey will continue to serve as consulting engineer to the hydraulic department of the company.

William C. Hammatt is now regional engineer for the Public Works Administration in San Francisco, covering the states of Arizona, California, Nevada, and Utah. Formerly, Mr. Hammatt was assistant state director in charge of the Los Angeles office of this organization.

George N. Schoonmaker, who has been serving as director of public service for the city of Toledo, Ohio, has been made chief engineer of the Toledo water department.

Arthur V. Sheridan, engineer of design for the Borough of the Bronx, New York City, has been appointed to represent the engineering profession on the recently created New York City Planning Commission, which will be the controlling factor in all the physical improvements of the city. Mr. Sheridan is also president of the National Society of Professional Engineers.

Frederick William Gardiner, for the past thirty years principal assistant engineer for the Interborough Rapid Transit Company, has been made chief engineer of the company, succeeding the late George H. Pegram.

George D. Brooke has been appointed president of the Chesapeake and Ohio Railway, succeeding the late William J. Harahan. Mr. Brooke has been an officer of the Chesapeake and Ohio since 1924 and served as executive vice-president during the past year.

DECEASED

Edwin Brightman (Jun. '33) of Syracuse, N.Y., died on October 6, 1937, at the age of 26. Mr. Brightman was born at Holyoke, Mass., and graduated from Syracuse University in 1933. In 1934 he served as instrumentman on a survey for the U. S. Coast and Geodetic Survey in Syracuse and then was chief of party for a drainage and ditch survey of the Smith-Canasota Company at Canasota, N.Y. Later Mr. Brightman was a draftsman in the pulp and paper department of the New York State College of Forestry at Syracuse.

Henry Stilson Farquhar (Assoc. M. '96) of Wayne, Pa., died on September 29, 1937, at the age of 68. Mr. Farquhar's early career included experience as inspector of sewers for Pensacola, Fla., and Stamford, Conn.; principal assistant engineer for the Baltimore (Md.) City Passenger Railway; and chief engineer for E. Saxton, contractor of Washington, D.C. For several years he was a member of the engineering firm of Paret and Farquhar, of Baltimore, and later he engaged in engineering and contracting work in Washington, D.C. For a number of years before his death he made his home in Wayne, Pa.

William Johnson Harahan (M. '03) president of the Chesapeake and Ohio Railway, the New York, Chicago and St. Louis Railroad, and the Pere Marquette Railway, died in a hospital at Clifton Forge, Va., on December 14, 1937. He was almost 70. Starting at the age of 14 with the Louisville and Nashville Railroad at New Orleans, Mr. Harahan achieved a notable career in railroad history, culminating in 1935 in the presidency of the three lines he headed at the time of his death. From 1892 to 1907 he served the Illinois Central Railroad in a variety of capacities; from 1907 to 1912 he was vice-president and chief engineer of the Erie Railroad; from 1912 to 1918, president of the Seaboard Air Line Railway; from 1918 to 1920, federal manager of the Seaboard Air Line Railway; and from 1920 to 1929, president of the Chesapeake and Ohio Railroad. In the latter year he resigned as president because of ill health and became senior vice-president of the Chesapeake and Ohio, serving in this capacity until 1935 when he was made president of the three railroads.

Ira Grant Hedrick (M. '00) consulting engineer of Hot Springs, Ark., died at his home there on December 28, 1937, at the age of 69. Mr. Hedrick was born in West Salem, Ill., and was educated at the University of Arkansas and McGill University. From 1892 to 1898 he was engaged in the design and supervision of bridges for J. A. L. Waddell; from 1898 to 1899, assistant to Robert Gillham, chief engineer of the Kansas City, Pittsburgh and Gulf Railway Company; and from 1899 to 1907 he was a member of the firm of Waddell and Hedrick, consulting engineers. In 1907 Mr. Hedrick established his own consulting practice. One of his major works was the Burnside Bridge in Portland, Ore., said to be one of the first lift-span bridges with car tracks and automatic trolley connections.

Sverre Lund (M. '13) of Worcester, Mass., died on April 3, 1937, at the age of 67. Mr. Lund was born in Drammen, Norway, and was educated at the Polytechnic Institute of Trondhjem, Norway. From 1892 to 1893 he was a draftsman for the Columbian Exposition in Chicago; from 1893 to 1894, a draftsman for the Westinghouse Electric Company; and from 1895 to 1900 a draftsman, checker, and inspector for the Boston Bridge Works. In 1900 Mr. Lund became connected with the Eastern Bridge and Structural Company, of Worcester, Mass., where he remained until 1933. During this period he was, successively, estimator, chief draftsman, designing engineer, chief estimator, sales manager, and chief engineer.

Joseph S. Morrison (M. '15) district highway engineer for the State Highway Commission at Ottumwa, Iowa, died suddenly on November 30, 1937, at the age of 63. Following his graduation from Iowa State College in 1897, Mr. Morrison served in the engineering department of the Chicago and Northwestern Railroad, where he remained until 1913. In the latter year he joined the Iowa State Highway Commission. He was shortly appointed district engineer at Ottumwa, remaining there until his death. Mr. Morrison was responsible for the design and construction of many highway and railway bridges in Iowa, Wisconsin, and Nebraska.

George Herndon Pegram (M. '83; Hon. M. '31) chief engineer of the Interborough Rapid Transit Company and Rapid Transit Subway Construction Company, New York City, died in Brooklyn, N.Y., on December 23, 1937. Dr. Pegram, who was 82, was born in Council Bluffs, Iowa, and graduated from Washington University (St. Louis) in 1877. From 1878 to 1880 he was principal assistant engineer for C. Shailer Smith; from 1880 to 1886, chief engineer for the Edge Moor Iron Company; from 1889 to 1893, consulting engineer for the Missouri Pacific Railroad; from 1893 to 1898, chief engineer for the Union Pacific System; and from 1898 to 1905, chief engineer for the Manhattan Elevated Railroad. In 1905 he became chief engineer for the Interborough Rapid Transit Company and the Rapid Transit Subway Construction Company. Dr. Pegram was long active in Society affairs, serving as Vice-President in 1909–

1910 and as President in 1917. A more detailed account of his career appears elsewhere in this issue.

Henry Irwin Randall (M. '06) of Berkeley, Calif., died on December 29, 1937. Mr. Randall was born at Pownal, Me., in 1863 and graduated from the University of California in 1887. Following his graduation, he became connected with the Southern Pacific Railroad Company, where he remained until 1890. From 1890 to 1895 he was an instructor in civil engineering at the University of California, and from 1895 to 1903 he served as assistant professor of civil engineering in the same institution. In the latter year he returned to the employ of the Southern Pacific Company. Mr. Randall was with this company for over twenty years—much of the time as assistant engineer. He retired several years ago.

Beale Melancthon Schmucker (Assoc. M. '17) county engineer of Camden County, New Jersey, died at his home in Camden on December 23, 1937, at the age of 49. Mr. Schmucker was born in Reading, Pa., on September 22, 1888, and was educated at the University of Pennsylvania. Following his graduation in 1910, he was assistant to the city engineer of Ocean City, N.J., where he remained until 1912. From the latter year on he was with the J. J. Albertson Company, engineers of Camden, and from the creation of the office in 1915 to 1929 he was assistant county engineer of Camden County. In 1929 he was made county engineer. During the war Mr. Schmucker served with the 104th Engineers, passing through the various ranks from private to captain.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Lawrence King Snyder (Jun. '32) who was in the bridge department of the St. Louis–San Francisco Railway, Springfield, Mo., died on November 14, 1937. Mr. Snyder was born at Linn Creek, Mo., on October 5, 1906, and graduated from the Missouri School of Mines in 1929. From 1929 to 1931 he was a designer in the bridge department of the St. Louis–San Francisco Railway Company, and from September 1931 to June 1932 he did graduate work at the Missouri School of Mines, earning the degree of M.S. in civil engineering. Mr. Snyder was in the bridge department of the Missouri State Highway Department in 1934, and in 1936 he again entered the employ of the St. Louis–San Francisco Railway.

Marvin Hugo Urbantke (Jun. '32) instrumentman for the Humble Oil and Refining Company, Houston, Tex., died in Paris, Tex., on March 10, 1937. Mr. Urbantke was born in Lexington, Tex., on, May 19, 1910, and graduated from Rice Institute in 1932. During the year preceding his graduation he was laboratory instructor in strength of materials and hydraulics at Rice Institute. From 1932 on, Mr. Urbantke was with the Humble Oil and Refining Company—first as transitman and, later, as instrumentman —for which he did surveying, camp and road construction, general drafting, and the design of a salt-water disposal system for the oil fields.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From December 10, 1937, to January 9, 1938, Inclusive

ADDITIONS TO MEMBERSHIP

Allen, George Wade (Jun. '37), 606 West Main St., Clinton, Ill.

Anderson, John David (Jun. '37), With The Austin Co., 510 North Dearborn St. (Res., 5656 Race Ave.), Chicago, Ill.

Andreassen, Alexander Torleiv (Jun. '37), 855 Fifty-eighth St., Brooklyn, N.Y.

Aronson, Cecil (Assoc. M. '37), Asst. Engr., Eastman Kodak Co. (Res., 124 Clay Ave.), Rochester, N.Y.

Ballard, John Scott (Jun. '37), With Wallace & Tiernan Co., Inc., Belleville (Res., 91 Grove St., Montclair), N.J.

Banks, Thomas Gray (Assoc. M. '37), Cons. Engr., 1425 North West 37th St., Oklahoma City, Okla.

Beall, Joel Chambless (Jun. '37), Box 87, Pickwick Dam, Tenn.

Beck, Joseph Frederick (Jun. '37), 709 Columbus Ave., New York, N.Y.

Bentley, Harold Roy (Jun '37), Res. Engr., Russell & Axon, Flat River (Res., 457 Hawthorne, Webster Groves), Mo.

Bigelow, Lawrence Neal (Jun. '37), 840 Madison St., Gary, Ind.

Boles, Chalmers Morton (Jun. '37), Turon, Kans.

Boothe, Raymond Hudson Ferris (Jun. '37), Senior Eng. Aid, State Dept. of Public Works, Div. of Highways, Dist. IX, Bishop, Calif.

Brant, Roger William (Jun. '37), Care, Medford Water Comm., Medford, Ore.

Bressi, Dominic John (Jun. '37), 1447 Seventy-eighth St., Brooklyn, N.Y.

Brogunier, Charles Henry (Jun. '37), 1017 Capitol Way, Olympia, Wash.

Caldwell, Charles George Winter (Jun. '37), Portales, N.Mex.

Carrick, Harry Hall, Jr. (Jun. '37), Draftsman, Western Pipe & Steel Co., Los Angeles (Res., 317 Norwich Drive, West Hollywood), Calif.

Castelan, Joe Terrazas (Jun. '37), Care, U. S. Bureau of Reclamation, Bartlett Dam, Cavecreek, Ariz.

Chenoweth, Harry Holt (Jun. '37), Care, U. S. Bureau of Reclamation, Colville, Wash.

Cisler, Lewis Delbert (Jun. '37), 714 Washington St., Marietta, Ohio.

Clark, Bradford Norman (Jun. '37), Engr. and Estimator, Frank Bracalello, Inc. (Res., 22 Seely Pl.), Scarsdale, N.Y.

Coe, Cleveland Beach (Assoc. M. '37), Asst. Highway Engr., TVA (Res., 1006 Hanover St.), Chattanooga, Tenn.

Collins, Don Warlick (Jun. '37), 209 North 4th, Chillicothe, Ill.

Cox, Kenneth Charles (Jun. '37), Fritz Eng. Laboratory, Lehigh Univ., Bethlehem, Pa.

TOTAL MEMBERSHIP AS OF JANUARY 9, 1938

Members	5,632
Associate Members	6,125
Corporate Members	11,757
Honorary Members	25
Juniors	3,624
Affiliates	78
Fellows	1
Total	15,485

Cultice, James Marvin (Jun. '37), Asst. Engr., FSA (Res., 1332 Gallatin St., N.W.), Washington, D.C.

De Carlo, James Francis Anthony (Jun. '37), 81 Bell St., Orange, N.J.

Denzer, Edward Michael (Jun. '37), 808 Herkimer St., Brooklyn, N.Y.

Diver, Harrison Morton, Jr. (Jun. '37), 2508 Ailsa Ave., Baltimore, Md.

Dobbin, John Ralph (Jun. '37), Chainman, State Highway Comm., Edmond, Kans.

Edmonston, Thomas Ritchie (Jun. '37), 12 East Market St., Bethlehem, Pa.

Edwards, William Herbert (Jun. '37), Levelman, U. S. Bureau of Public Roads, Long Creek, Ore.

Esterman, Joseph Michael (Jun. '37), Senior Eng. Aid, State-Wide Highway Planning Survey; 3228 Marshall Way, Sacramento, Calif.

Evans, George William (Jun. '36), Care, Post Roads Div., State Highway Dept., Clayton, Ga.

Evans, William Jason (Assoc. M. '37), Field Engr., Strauss & Paine, Inc., 2083 Harrison Boulevard, Oakland, Calif.

Fichtmueller, Frederick Adolph (Jun. '37), 255 Howard Ave., Staten Island, N.Y.

Firling, Christian Winslow (Jun. '37), Paramus Rd., Ridgewood, N.J.

Foster, Edgar Eugene (Assoc. M. '37), U. S. Engr. Office, 1068 Navy Bldg., Washington, D.C.

Franzen, Earl Theodore (Jun. '37), 411 Second St., West, Willmar, Minn.

Fraser, R. Lee (Jun. '37), Asst. to K. W. Lefever, Little Rock (Res., McCrory), Ark.

Fratar, Thomas Joseph (Jun. '37), Chf. of Party, Madigan-Hyland, 608 West 227th St., New York, N.Y.

Frickland, Loren Lilliard (Jun. '37), 828 University Ave., S. E., Minneapolis, Minn.

Gage, Richard Henry (Jun. '37), 3812 North Lowell Ave., Chicago, Ill.

Granger, Laurence Frederic (Jun. '37), 24 West 91st St., New York, N.Y.

Green, Giles George (Jun. '37), 488 Beacon St., Boston, Mass.

Green, Richard Stedman (Jun. '37), 101 Willow Ave., Somerville, Mass.

Hagy, Richard Claude (Jun. '37), 138 West Mount Airy Ave., Mount Airy, Philadelphia, Pa.

Hall, Harold Maulding (Jun. '37), Sub.-Insp. of Dredging, U. S. Engrs. Laboratory, Box 903, Fort Peck, Mont.

Hamilton, Taber, Jr. (Jun. '37), Insp., P.R.R., Downingtown (Res., 7207 Charlton St., Philadelphia), Pa.

Hansen, Norman Groves (Jun. '37), 928 Waverley St., Palo Alto, Calif.

Harrison, Josiah James (Jun. '37), Lindsay, Okla.

Harvey, Francis Stephen (Jun. '37), 24 West 91st St., New York, N.Y.

Hastings, David Canfield (Jun. '37), 1410 Confederate Ave., Richmond, Va.

Henderson, Loyal Reid (Jun. '37), 924 Sunset Ave., Asbury Park, N.J.

Hooper, William Thomas Francis, Jr. (Jun. '37), 625 North Laramie Ave., Chicago, Ill.

Hopkins, Leonard Otis, Jr. (Jun. '37), With TVA (Res., 1640 West Cumberland Ave.), Knoxville, Tenn.

Hunt, Gilbert Agnew (M. '37), Hydr. Engr., Phoenix Eng. Corporation, New York (Res., 1147 East 28th St., Brooklyn), N.Y.

Huttleston, Leonard Lamont (Assoc. M. '37), 70 Howe St., New Haven, Conn.

Ives, Howard Smith (Assoc. M. '37), Asst. Project Engr., State Highway Dept. (Res., 2 Perry Ave.), Portland, Conn.

Jensen, Ray (Jun. '37), 2575 Mission St., San Marino, Calif.

Kallgren, Harry Richard (Assoc. M. '37), Asst. Civ. Engr., Dept. of Public Works, City of Detroit (Res., 5090 Haverhill Rd.), Detroit, Mich.

Kaufman, Walter Jackson, Jr. (Jun. '37), The Southern Club, 810 North Broad St., Elizabeth, N.J.

Kaya, Bedros (Jun. '37), 34 Sahin Sinem Köy Kurtulus, Istanbul, Turkey.

Kiel, Paul Martin (Jun. '37), With Floyd G. Browne, 611 South Prospect St., Marion, Ohio.

Kiepe, Quinton Richard (Jun. '37), 37 Isabella Ave., Newark, N.J.

Kingman, Dean Stanley (Jun. '37), Laboratory Helper, Peoples Gas, Light & Coke Co. (Res., 7214 Woodlawn Ave.), Chicago, Ill.

Kovtynovich, John (Jun. '37), 336 Sixth St., Oswego, Ore.

Kunitzky, Frederick (Jun. '37), 1264 Sheridan Ave., New York, N.Y.

Lieber, Albert Carl, Jr. (M. '37), Maj., Corps of Engrs., U.S.A., the Command and General Staff School, 315 Pope Ave., Fort Leavenworth, Kans.

Livesay, Patty Craig (Jun. '37), 1534 Roberts Ave., Whiting, Ind.

Lix, Joseph Daniel (Jun. '37), 4521 Seventh St., N.W., Washington, D.C.

Logan, Samuel Tolbert (Jun. '37), Hillcrest Hotel, Old Hickory, Tenn.

McCall, Richard Hawley (Jun. '37), Box 2554, College Station, Tex.

McCrone, John Roy, Jr. (Assoc. M. '36), (McCrone, Jones & Hicks), Annapolis (Res., Forest View Rd., Linthicum P.O., Linthicum Heights), Md.

McLeod, Robert John (Jun. '37), 2030 Upland Way, Philadelphia, Pa.

Marquette, Louis Leddon (Jun. '37), 403 East Doddridge, Kingsville, Tex.

Marsh, James Spencer (Jun. '37), Care, State Highway Dept., Olympia, Wash.

Masciocchi, Pius James (Jun. '37), 49 West Granada Ave., Hershey, Pa.

Mészáros, Leslie Joseph Michael (Jun. '37), 158 Humphrey St., New Haven, Conn.

Milhollin, Austin Barlow (Jun. '37), 151 South State St., Salt Lake City, Utah.

Miller, Edward Jeremiah, Jr. (Jun. '37), Insp., State Highway Dept., Box 82, Tillatoba, Miss.

Mullen, James McLean (Jun. '37), 362 Third St., Sausalito, Calif.

Norton, John Comstock (Jun. '37), Structural Designer, Hinchman & Grylls, 800 Marquette Bldg. (Res., 925 Whitmore Rd.), Detroit, Mich.

Osterberg, Johj Oscar (Jun. '37), 107 Catherine St. Ithaca, N.Y.

Peruggi, Frank Ernest (Jun. '37), 1872 West 11th St., Brooklyn, N.Y.

Pope, Walter Joseph (Jun. '37), 2418 St. Raymond's Ave., New York, N.Y.

Price, Robert Carmel (Assoc. M. '37), Prin. Constr. Engr., Puerto Rico Reconstruction Administration, Adjuntas, Puerto Rico.

Ralph, Orville Marshall (Jun. '37), 123 West St. Charles St., Brownsville, Tex.

Randolph, Gayle Bowden, Jr. (Jun. '37), Madisonville, Tex.

Rathburn, Robert Edison (Jun. '37), 5282 Second Boulevard, Detroit, Mich.

Rawlins, Carl Elbert (Jun. '37), Box 791, Midland, Tex.

Rhode, Robert Berg (Jun. '37), 2109 East 2d St., Duluth, Minn.

Rhoton, Donald Gale (Jun. '37), Box 178, Pickwick Dam, Tenn.

Riepe, Carl Ripley (Jun. '37), with Currie Eng. Co., Webster City (Res., 2138 Sunset Drive, Ames), Iowa.

Robey, Harry Francis, Jr. (Jun. '37), with Eng. Dept., Aluminum Co. of America, Aluminum Club, New Kensington, Pa.

Romeo, Anthony Frank (Jun. '37), 23–49 Twenty-Seventh St., Astoria, N.Y.

Santi, Mark Giovacchino (Jun. '37), Box 26, Waco, Tex.

Sarven, Harvey Ward (Jun. '37), 58 Linwood Pl., East Orange, N.J.

Sayler, Francis Albert (Jun. '37), 3025 South Virginia Rd., Los Angeles, Calif.

Scher, Marvin Bertram (Jun. '37), 82 Broadway, Newark, N.J.

Schlick, Julius Reid (Jun. '37), 501 Twenty-Seventh St., South, Bessemer, Ala.

Sellner, Edward (Jun. '37), Instr., Civ. Eng. Dept., Agri. and Mech. Coll. of Texas, College Station, Tex.

Sewell, James Arthur (Jun. '37), North 1012 Clay St., Colfax, Wash.

Sholtes, Charles Alfred (Jun. '37), 117 Grand St., Schoharie, N.Y.

Shuldiner, William (Jun. '37), 3451 Giles Pl., New York, N.Y.

Smithmeyer, Philip Ramberg (Jun. '37), 4714 Eighteenth Ave., N.E., Seattle, Wash.

Strong, Sheldon Arthur (Jun. '37), Junior Draftsman, State Highway Dept. (Res., 507 South Race St.), Denver, Colo.

Sutherland, Lewis Bird (Assoc. M. '37), Asst. Prof., Architectural Eng., Univ. of Colorado (Res., 860 Twentieth St.), Boulder, Colo.

Swidzinski, Edmund (Jun. '37), 33 Lowe St., Quincy, Mass.

Tentschert, Francis Ferdinand (Jun. '37), Care, The Dorr Co., 570 Lexington Ave., New York, N.Y.

Thomas, Paul Louis (Jun. '37), 5132 South Blackstone, Chicago, Ill.

Trotter, Claude Houston (Jun. '37), Rodman, A. T. & S. F. Ry.; 2415 North 10th St., Kansas City, Kans.

Tuskind, Eugene Randall (Assoc. M. '37), Office Engr., State Highway Dept. (Res., 612 Raymond St.), Bismarck, N. Dak.

Wahlborg, Karl Stanley (Jun. '37), 2818 Fairview North, Seattle, Wash.

Warrington, Francis Carlton (Jun. '37), Y.M.C.A., Coraopolis, Pa.

Wedge, Arthur Henry (Assoc. M. '37), City Mgr., 683 Broadway, Bedford, Ohio.

Wenderoth, Henry John (Jun. '37), 660 North Cottage St., Salem, Ore.

Wetzel, John Henry (Jun. '37), Asst. Regional Engr., SCS, U. S. Dept. of Agriculture, Kutztown, Pa.

Whitman, Worsham Carroll (Jun. '37), Instrumentman, State Highway Dept., Box 190, Bowie, Tex.

Witte, Herbert Walter (Jun. '37), Draftsman, State Highway Dept. (Res., 846 Ponce de Leon Ave., N.E., Apartment 4), Atlanta, Ga.

Wolf, Robert Joseph (Jun. '37), 851 Virginia Park, Detroit, Mich.

Young, David (Jun. '37), 554 Adams, Memphis Tenn.

Membership Transfers

Calvert, John Thornton (Jun. '34; Assoc. M. '37), Chemist, Bacteriologist, and Eng. Asst., Messrs. John Taylor & Sons, Caxton House, Westminister, London, S.W.1 (Res., 61, Half Moon Lane, Herne Hill, London, S.E. 24), England.

Gellert, Nathan Henry (Assoc. M. '17; M. '37), Pres., National Public Utilities Corporation; Pres., Great Lakes Utilities Co., Packard Bldg., Philadelphia, Pa.

Graham, Harry Edward (Jun. '31; Assoc. M. '37), Res. Engr., Mene Grande Oil Co., C. A., Apartado 234, Maracaibo, Venezuela.

Grant, Eugene Lodewick (Assoc. M. '26; M. '37), Associate Prof., Civ. Eng., Stanford Univ., Stanford University, Calif.

Hermida, Thomas Joseph (Jun. '34; Assoc. M. '37), Res. Engr. Insp., FSA, Box B, Fairfield, Mont.

Johannessen, Walter (Assoc. M. '32; M. '37), Traveling Engr. Insp., PWA; 917 West Moreland St., Phoenix, Ariz.

Larson, Donald Edward (Jun. '30; Assoc. M. '37), Development Engr., Chicago Bridge & Iron Co., 1305 West 105th St. (Res., 10512 South Claremont St.), Chicago, Ill.

Pickett, Charles Marvin, Jr. (Jun. '26; Assoc. M. '37), Draftsman, Park Dept., Boston (Res., 800 Centre St., Jamaica Plain), Mass.

Schmied, Erich Ernest (Assoc. M. '23; M. '37), (S & W Constr. Co.), 983 Shrine Bldg., Memphis, Tenn.

Vogel, Herbert Davis (Assoc. M. '32; M. '37), Capt., Corps of Engrs. U.S.A., 3d Engrs., Schofield Barracks, Honolulu, Hawaii.

Vollmer, Alexander Russell (Jun. '28; Assoc. M. '37), Asst. Engr., Whitman, Requardt & Smith (Res., 6019 Bellona Ave.), Baltimore, Md.

Waldbillig, Gerald William (Jun. '31; Assoc. M. '37), Pres., John B. Waldbillig, Inc., 400 Second St., Albany, N.Y.

Wills, Ronald Blair (Assoc. M. '28; M. '37), Engr. of Design, State Highway Comm., Masonic Bldg. (Res., 1255 Plass), Topeka, Kans.

Reinstatements

Andrews, Alfred Stokes, Assoc. M., reinstated Jan. 1, 1938.

Bailey, Robert William, Jr., Assoc. M., reinstated Jan. 1, 1938.

Buckman, Henry Holland, M., reinstated Dec. 13, 1937.

Carrick, Richard Scott, Assoc. M., reinstated Jan. 5, 1938.

Ellis, Richard, M., reinstated Aug. 16, 1937.

Ewell, Andrew Travers, M., reinstated Jan. 1, 1938.

Frankland, Frederick Herston, M., reinstated Dec. 23, 1937.

Hartigan, Augustus Fisher, Assoc. M., reinstated Jan. 3, 1938.

Jacobs, Roy Kenneth, Jun., reinstated Jan. 1, 1938.

Leigh, James Bell, Assoc. M., reinstated Jan. 5, 1938.

Mannes, Arthur Siverine, Assoc. M., reinstated Jan. 7, 1938.

Mayper, Victor, M., reinstated Jan. 1, 1938.

Pfau, Albert Lincoln, Jr., Assoc. M., reinstated Jan. 1, 1938.

Vogel, Joshua Holmes, M., reinstated Jan. 1, 1938.

Wandmacher, Frederick Cornelius, Jun., reinstated Jan. 1, 1938.

Warren, Ray, Assoc. M., reinstated Jan. 1, 1938.

Weaver, Russell Reiss, Assoc. M., reinstated Nov. 22, 1937.

Winter, Hugo Herman, Assoc. M., reinstated Jan. 1, 1938.

Worcester, Thomas, Assoc. M., reinstated Jan. 1, 1938.

Resignations

Adams, William Herbert, Jun., resigned Dec. 30, 1937.

Anderson, William Townsend, Assoc. M., resigned Dec. 20, 1937.

Avery, Theodore Albert, M., resigned Dec. 31, 1937.

Bailey, Lewis Penn, Assoc. M., resigned Jan. 5, 1938.

Bates, William Lewis, Jun., resigned Dec. 30, 1937.

Blake, Paul, Jun., resigned Dec. 27, 1937.

Blank, Charles Edward, Jun., resigned Dec. 31, 1937.

Burton, Walter Edgar, Jun., resigned Dec. 21, 1937.

Bush, William Hector, M., resigned Dec. 20, 1937.

Campbell, Benjamin Lucien, M., resigned Dec. 20, 1937.

Carpio, Gabriel Dumlao, Jun., resigned Dec. 27, 1937.

Cook, Auley Almerin, Assoc. M., resigned Dec. 14, 1937.

Coote, Charles Warren, Assoc. M., resigned Jan. 4, 1938.

Corcoran, Louis Paul, Assoc. M., resigned Dec. 31, 1937.

Daniels, Marcell Deets, Jun., resigned Dec. 31, 1937.

DeFrees, Raymond Garfield, Assoc. M., resigned Dec. 30, 1937.

Dewey, Earl Kent, Assoc. M., resigned Dec. 31, 1937.

Dolan, Thomas James, Jun., resigned Dec. 10, 1937.

England, Arthur Clifford, Jr., Jun., resigned Dec. 30, 1937.

Grayson, Lincoln Blaisdell, Jun., resigned Dec. 30, 1937.

Himmelman, Carl Conrad, Jun., resigned Dec. 30, 1937.

Holcomb, Harvey Morris, Jun., resigned Dec. 31, 1937.

Howard, James Murray, Jun., resigned Dec. 30, 1937.

Kish, Frank Joseph, Jun., resigned Dec. 30, 1937.

Kochman, Emil Joseph, Jr., Jun., resigned Dec. 30, 1937.

Lawler, Russell Bernard, Jun., resigned Dec. 31, 1937.

Leech, James Harold, Assoc. M., resigned Jan. 4, 1938.

Memory, Duncan Thomas, Assoc. M., resigned Dec. 10, 1937.

Miller, Harold Eugene, Jun., resigned Dec. 30, 1937.

Morris, William Chester, Assoc. M., resigned Dec. 23, 1937.

Neider, Russell Charles, Jun., resigned Dec. 10, 1937.

Pacheco, Francisco Hugo Ortuno, Jun., resigned Jan. 4, 1938.

Porter, Arthur Miller, Assoc. M., resigned Jan. 4, 1938.

Schamberger, Sanford Oatman, Assoc. M., resigned Dec. 17, 1937.

Shepard, Henry Hudson, M., resigned Dec. 23, 1937.

Turken, Morris William, Jun., resigned Dec. 13, 1937.

Wallace, John Herbert, Jr., Assoc. M., resigned Dec. 14, 1937.

Weinstein, Howard, Jun., resigned Jan. 4, 1938.

Wellner, John Arnold, Jun., resigned Dec. 30, 1937.

Wertz, Harry Ray, Assoc. M., resigned Dec. 30, 1937.

West, Judson Ray, M., resigned Dec. 28, 1937.

Whitwell, Edward, Assoc. M., resigned Dec. 30, 1937.

Woodward, Austin Clair, Jun., resigned Dec. 31 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

February 1, 1938 — Number 2

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Allen, Harvey Hicks, Austin, Tex. (Age 37.) Asst. to State Highway Engr., Texas Highway Dept. on National Recovery Work Relief Program. Refers to D. H. Askew, G. A. Bracher, G. G. Edwards, J. A. Focht, B. B. Freeborough, G. Gilchrist, T. J. Kelly, H. C. Porter, T. U. Taylor.

Bass, John Howard, Columbus, Ohio. (Age 30.) Asst. Engr., Ohio Dept. of Health. Refers to F. G. Browne, C. T. Morris, C. E. Sherman, F. D. Stewart, F. H. Waring.

Beeghly, Floyd J., Phoenix, Ariz. (Age 37.) Res. Engr., Arizona Highway Dept. Refers to F. N. Grant, R. A. Hoffman, W. R. Hutchins, I. P. Jones, Jr., W. W. Lane, E. V. Miller, J. W. Powers.

Berg, Merlin Hanson, Minneapolis, Minn. (Age 25.) Jun. Engr., U. S. Engr. Office, St. Paul, Minn. Refers to E. F. Brownell, W. Z. Lidicker.

Black, Hayse Henry, Springfield, Ill. (Age 31.) Asst. State San. Engr., Illinois Dept. of Public Health. Refers to H. E. Babbitt, J. J. Hinman, Jr., R. P. Hoelscher, H. A. Spafford, A. H. Wieters, J. J. Woltmann.

Blakeslee, L. Robert, Detroit, Mich. (Age 32.) Asst. Prof., Univ. of Detroit; also Archt. Refers to A. S. Douglass, C. C. Johnston, C. J. J. Pajot, H. L. Russell, R. H. Sherlock, A. L. Trout.

Brown, James Wesley, McComb, Miss. (Age 35.) City Engr. Refers to E. L. Browning, G. R. Clemens, J. H. Dorroh, W. W. Hall, M. Johnson, P. O. Roberts, G. E. Tomlinson, K. R. Young.

Bryan, Lloyd, Huntington Park, Calif. (Age 34.) Engr., Industrial Eng. Co., Los Angeles, Calif. Refers to E. E. Blackie, E. N. Bryan, P. R. Quick, R. H. Taylor, C. L. Young.

Bunker, William Beehler, Boston, Mass. (Age 27.) With U. S. Engr. Office, Boston Dist., acting as Asst. to Area Engr. Refers to C. B. Breed, H. C. Byrnes, H. J. Casey, K. C. Reynolds, J. H. Stratton, D. W. Taylor, R. C. Vogt.

Campbell, Elmer Wilmot, Augusta, Me. (Age 41.) Director, Div. of San. Eng., State of Maine. Refers to F. C. Dugan, H. E. Miller, E. D. Rich, W. J. Scott, H. W. Streeter, A. D. Weston.

Cudworth, Arthur George, Denver, Colo. (Age 30.) Structural Engr., Western Portland Cement Association. Refers to C. L. Eckel, R. B. Houston.

Davidson, Hebert, Chicago, Ill. (Age 35.) Designer and Chf. Engr., Waddell & Hardesty, Cons. Engrs. Refers to T. E. Brown, F. De Schauensee, S. Hardesty, A. Hedefine, J. A. L. Waddell, H. E. Wessman.

Ebersole, Gordon Keith, Ephrata, Wash. (Age 27.) Jun. Instrumentman, Grade 9, U. S. Bureau of Reclamation. Refers to F. A. Banks, F. M. Berry, J. S. Dodds, F. Kerekes, L. O. Stewart.

Fischer, Ernest William, Baltimore, Md. (Age 24.) Engr. and Draftsman, Baltimore

County Metropolitan Dist., Towson, Md. Refers to W. T. Ballard, T. F. Comber, Jr., F. W. Medaugh, G. C. Saunders, O. H. Schroedl, A. F. Shure.

Forbes, Rolland Franklin, Toledo, Ohio. (Age 32.) Asst. Engr., Ohio State Dept. of Highways. Refers to R. W. Abbott, W. A. Hill, P. W. McDonnell, C. B. Patterson, A. H. Smith.

French, John Lawrence, Atlanta, Ga. (Age 29.) Jun. Engr., U. S. Geological Survey. Refers to A. D. Ash, F. M. Bell, J. K. Finch, A. H. Horton, M. T. Thomson.

Gallagher, Charles Richard, Ventura, Calif. (Age 22.) With California Div. of Highways. Refers to S. T. Harding, C. T. Wiskocil.

Gilmore, Ross Angus, Galveston, Tex. (Age 32.) Jun. Hydrographic and Geodetic Engr., U. S. Coast and Geodetic Survey. Refers to F. S. Borden, H. B. Campbell, C. K. Green, E. O. Heaton, L. P. Raynor, G. T. Rude, O. W. Swainson.

Gow, Frederick William, Enfield, Mass. (Age 40.) Senior Civ. Engr. on Quabbin Dam, Commonwealth of Massachusetts, Metropolitan Dist. Water Supply Comm. Refers to E. C. Hultman, K. R. Kennison, W. W. Lewis, W. W. Peabody, T. F. Sullivan, F. E. Winsor.

Guirey, Fred Melville, Phoenix, Ariz. (Age 29.) Landscape Engr., Arizona Highway Dept. Refers to V. H. Housholder, W. R. Hutchins, G. L. McLane, E. V. Miller, C. C. Morris, C. Myers, M. R. Tillotson.

Hamilton, William Clark, Fayette, Miss. (Age 30.) Instrumentman, Mississippi Highway Dept., Jackson, Miss. Refers to E. L. Erickson, H. B. Henderlite, J. E. Kidd, N. E. Lant, K. R. Young.

Hanselman, Richard Malcolm, Rossford, Ohio. (Age 26.) Draftsman and Designer, Constr. Eng. Dept., Libbey-Owens-Ford Co. Refers to R. W. Abbott, C. S. Finkbeinert, W. H. Hasselbach, P. W. McDonnell.

Harkrider, Clovis Joseph, Llano, Tex. (Age 27.) Asst. Res. Engr. Inspector, PWA. Refers to H. E. Elrod, H. A. Hunter, J. L. Lochridge, L. B. Ryon, Jr., G. C. Street, Jr., F. J. Von Zuben, W. E. White.

Heyl, Edward Randolph, Merchantville, N.J. (Age 48.) Supt., Public Works Dept., Philadelphia Navy Yard. Refers to E. R. Gayler, C. R. Johnson, W. Z. Kline, J. J. Manning, W. F. Miller, J. J. Sweeney, W. L. Taylor.

Johnson, John Daniel, Ft. Worth, Tex. (Age 45.) Engr. and Contr. Refers to J. H. Brillhart, T. S. Byrne, R. O. Jameson, W. O. Jones, C. M. Thelin.

Johnston, Hugh Wellford, Portsmouth, Va. (Age 29.) Draftsman, Norfolk Southern R.R., Norfolk, Va. Refers to W. D. Faucette, E. A. Frink, H. H. George, F. L. Nicholson, A. M. Traugott, T. J. Wright, Jr.

Kammer, Herbert Anthony, Valley Stream, N.Y. (Age 35.) Asst. Design Engr., American Gas & Elec. Co., New York City. Refers to R. W. Carlson, A. V. Karpov, F. W. Scheidenhelm, H. S. Slocum, J. B. Snethlage, R. H. Stearns.

Kelly, Warren Winfield, Amarillo, Tex. (Age 52.) With Panhandle & Santa Fe and Atchison Topeka & Santa Fe Ry. Cos., Western Lines, as Chf. Engr. at Amarillo. Refers to M. C. Blanchard, R. C. Gowdy, G. W. Harris, C. S. Lambie, H. C. Phillips, R. A. Van Ness.

Kesler, Mack Smith, Salt Lake City, Utah. (Age 26.) With Dist. Director, WPA, as Chf. Engr. on Salt Lake City Airport. Refers to T. C. Adams, R. B. Ketchum, F. H. Richardson.

McDonald, Everett Keith, Decatur, Ill. (Age 39.) City Engr. Refers to C. H. Apple, G. H. Baker, L. N. Fisher, A. Van Praag, Jr., W. D. P. Warren, F. L. Washburn.

Moore, Clarence Hilton, Jacksonville, Fla. (Age 43.) Pres., The Aetna Iron & Steel Co. Refers to C. R. Bloxton, N. W. Green, S. S. Jacobs, J. W. Leroux, J. G. Moore, A. F. Perry, Jr., J. F. Reynolds, R. E. Spaulding, J. A. L. Waddell.

Mott, Thomas Clayton, Los Banos, Calif. (Age 51.) Chf. Engr. and Mgr., Miller & Lux, Inc. Refers to H. Barnes, H. J. Deutschbein, B. A. Etcheverry, H. L. Haehl, H. M. Hale, F. C. Herrmann, S. A. Kerr, J. B. Lippincott, R. Ridgway, G. L. Swendsen, L. White.

Nelson, Martin Emil, Iowa City, Iowa. (Age 40.) Associate Engr., U. S. Engr. Office, St. Paul, Minn. Refers to H. M. Hill, J. W. Howe, R. G. Kasel, B. J. Lambert, E. W. Lane, G. E. Lyon, F. T. Mavis.

Newberry, James Moses, Neodesha, Kans. (Age 53.) City Engr. Refers to E. B. Black, J. W. Ivy, A. P. Learned, F. A. Russell, F. M. Veatch, N. T. Veatch, Jr.

Okkerse, John Bertram, Flushing, N.Y. (Age 26.) Asst. to Contract Mgr. and Purchasing Agt., Marc Eidlitz & Son, Inc., New York City. Refers to R. I. Land, D. T. Webster.

Ott, Clifford Spencer, New York City. (Age 28.) Jun. Asst. Engr. with Malcolm Pirnie. Refers to W. C. McNaughton, M. Pirnie.

Philips, Reuben Littleton, Oklahoma City, Okla. (Age 35.) Bridge Engr., J. B. Klein Iron & Foundry Co. Refers to J. F. Brookes, W. C. Burnham, V. H. Cochrane, G. H. James, C. Schultz.

Platt, Doran Stone, Jr., Washington, D.C. (Age 23.) Engr., Platt & Davis, Inc., being Supt. of construction. Refers to H. R. Hall, G. A. Wick.

Robbins, James Melvin, Maplewood, N.J. (Age 35.) Asst. Prof. of Civ. Eng., Newark Coll. of Eng., Newark, N.J. Refers to J. B. Babcock, 3d, G. E. Barnes, H. L. Bowman, C. B. Breed, H. N. Cummings, C. W. Dunham, W. S. LaLonde, Jr.

Shoemaker, Sydney Arthur, Cleburne, Tex. (Age 38.) Traffic Analysis Engr., Blanket Count Supervisor and Draftsman, Texas State Highway Dept. Refers to C. L. Hasie, M. B. Hodges, L. C. Ingram, Jr., F. E. Lovett, S. R. Mitchell.

Smirnoff, Michael Viacheslav, Pittsburgh, Pa. (Age 39.) Designing Draftsman, Dept. of Design, Bureau of Streets and Sewers. Refers to H. S. Ayres, F. J. Evans, F. M. McCullough, H. A. Thomas, C. M. Vetter.

Smith, Marlin Rocelius, Jr., Lubbock, Tex. (Age 34.) City Engr. Refers to J. H. Murdough, M. C. Nichols, F. B. Ogle, G. W. Parkhill, H. N. Roberts.

Stevens, James Winlock, Spur, Tex. (Age 28.) Asst. Res. Engr., Texas State Highway Dept. Refers to W. H. Garrett, L. C. Ingram, Jr., E. W. Mars, F. B. Ogle.

Turrentine, Robert Emmett, Jr., Houston, Tex. (Age 33.) Engr. and Contr. Refers to R. J. Cummins, C. R. Haile, J. G. McKenzie, J. C. McVea, W. P. Moore, L. B. Ryon, Jr., A. J. Wise.

Villamizar, Luis Carlos, New Orleans, La. (Age 24.) With R. P. Farnsworth & Co. Refers to E. S. Bres, D. Derickson.

Williams, Clyde Elmer, Plainfield, Ind. (Age 35.) Engr., Bureau of San. Eng., Indiana State Board of Health. Refers to C. B. Carpenter, L. M. Gram, C. H. Hurd, F. Kellam, W. A. Knapp, G. E. Lommel, H. E. Miller, J. W. Moore, H. S. Morse, L. V. Sheridan, R. B. Wiley.

Winder, John Ben, Dallas, Tex. (Age 54.) Supt. of Water-Works and Sewage-Disposal System, City of Dallas. Refers to J. T. Conroy, E. Couch, T. C. Forrest, Jr., O. H. Koch, E. L. Myers, E. N. Noyes, A. P. Rollins, C. L. Williford.

Winn, Herbert Poston, Tionesta, Pa. (Age 31.) Asst. Res. Engr., U. S. Engr. Office, on Tionesta Dam, Flood Control. Refers to N. W. Bowden, W. E. R. Covell, H. A. Hickman, H. P. McKown, H. K. Shriver, L. G. Warren, S. A. Weakley.

Withycombe, Earl, Sacramento, Calif. (Age 45.) Asst. Constr. Engr., California Div. of Highways. Refers to F. J. Grumm, F. W. Panhorst, C. S. Pope, T. E. Stanton, Jr., R. H. Wilson.

Woolpert, Ralph Lash, Dayton, Ohio. (Age 40.) Putnam & Woolpert. Refers to G. F. Baker, N. J. Bell, C. S. Bennett, E. O. Brown, J. F. Hale, C. H. Paul, C. D. Putnam.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Couse, Walter Learned, Assoc. M., Detroit, Mich. (Elected June 26, 1931.) (Age 36.) Member of firm, Couse & Saunders, Engrs. and Contrs. Refers to L. E. Ayres, J. H. Cissel, W. R. Drury, W. C. Hirn, E. P. Lupfer, H. E. Riggs.

Dawson, Raymond Fillmore, Assoc. M., Austin, Tex. (Elected Junior Aug. 4, 1924; Assoc. M. Feb. 10, 1930.) (Age 37.) Testing Engr., Bureau of Eng. Research, Univ. of Texas. Refers to E. C. H. Bantel, H. F. Clemmer, P. M. Ferguson, S. P. Finch, J. A. Focht, W. K. Hatt, T. U. Taylor, R. B. Wiley.

Duff, Carl Mathias, Assoc. M., Lincoln, Nebr. (Elected May 8, 1922.) (Age 53.) Prof. of Eng. Mechanics, Univ. of Nebraska; also Testing Engr., Nebraska Dept. of Roads and Irrigation. Refers to F. T. Darrow, R. E. Edgecomb, M. I. Evinger, R. M. Green, H. J. Kesner, J. G. Mason, C. E. Mickey.

Greer, Dewitt Carlock, Assoc. M., Austin, Tex. (Elected Junior Dec. 5, 1927; Assoc. M. Feb. 10, 1930.) (Age 35.) Chf. Engr., Construction and Design, Texas State Highway Dept. Refers to G. Gilchrist, W. S. Hanley, T. E. Huffman, A. C. Love, J. E. Pirie.

Grinter, Linton Eli, Assoc. M., Chicago, Ill. (Elected Junior March 15, 1926; Assoc. M. Aug. 26, 1929.) (Age 35.) Director of Civ. Eng. and Dean of Graduate Div., Armour Inst. of Technology. Refers to E. P. Arneson, H. Cross, M. L. Enger, F. E. Giesecke, F. T. Mavis, J. J. Richey, C. E. Sandstedt, A. N. Talbot, C. C. Williams.

Herring, Francis William, Assoc. M., Chicago, Ill. (Elected Junior June 6, 1921; Assoc. M. June 4, 1928.) (Age 38.) Executive Director, American Public Works Association. Refers to V. T. Boughton, T. Buckley, W. W. DeBerard, G. H. Fenkell, L. G. Lenhardt, A. B. Morrill, F. E. Schmitt.

Jacka, Samuel Curno, Assoc. M., Lansing, Mich. (Elected Jan. 16, 1928.) (Age 42.) City Engr. Refers to O. E. Eckert, E. D. Rich, H. E. Riggs, E. C. Shoecraft, E. R. Weeber.

Jansen, Carlton B., Assoc. M., Pittsburgh, Pa. (Elected May 12, 1930.) (Age 37.) Asst. to Gen. Mgr., Contr. Div., Dravo Corporation (successor to Dravo Contr. Co.). Refers to E. H. Connor, A. W. Dann, R. Farnham, C. E. Myers, E. E. Paul, F. G. Schworm, J. H. C. Sprague, C. H. Stevens, W. C. Taylor, G. B. Woodruff.

Jewett, Joseph Eugene, Assoc. M., Rock Island, Ill. (Elected April 15, 1929.) (Age 37.) Senior Engr. in charge of Lands Sec., U. S. Engr. Office. Refers to R. E. Coughlin, A. F. Griffin, R. E. Mackenzie, C. S. Nichols, C. A. Shockley, H. P. Warren, D. L. Wilson, R. H. Wilson.

Komora, Andrew Mitchell, Assoc. M., Norris, Tenn. (Elected Nov. 18, 1935.) (Age 36.) Asst. Constr. Engr., TVA, Norris Dam. Refers to C. A. Bock, J. S. Bowman, G. R. Clemens, H. L. Fruend, B. M. Jones, T. B. Parker, R. White.

Lee, Donovan Henry, Assoc. M., London, S.W.1, England. (Elected Junior March 16, 1925; Assoc. M. Feb. 24, 1931.) (Age 37.) Chf. Engr., Christiani & Nielsen, Ltd., Reinforced Concrete Engrs. Refers to C. E. Beam, B. S. Voorhees. (Applies in accordance with Sec. 1, Art. I, of the By-Laws.)

McEntire, Lloyd, Assoc. M., Saylorsburg, Pa. (Elected Junior Sept. 2, 1914; Assoc. M. May 31, 1916.) (Age 50.) In private practice. Refers to J. D'Esposito, A. Hirst, C. A. Mead, A. H. Nelson, G. F. Pawling, E. M. Vail.

Maddox, Edward Finnin, Assoc. M., Dallas, Tex. (Elected Nov. 27, 1933.) (Age 45.) Res. Engr. with Texas Highway Dept. Refers to R. C. Black, G. A. Bracher, G. Gilchrist, T. J. Kelly, J. M. Page, J. G. Rollins, W. P. Stine, M. C. Welborn, G. G. Wickline.

Rady, Joseph, Assoc. M., Fort Worth, Tex. (Elected Jan. 17, 1927.) (Age 39.) Gen. and Cons. Engr. Refers to J. S. Barlow, J. H. Brillhart, E. N. Gustafson, J. Montgomery, M. C. Nichols, H. N. Roberts, G. C. Street, Jr.

Smith, Leroy Clarke, Assoc. M., Detroit, Mich. (Elected Jan. 6, 1915.) (Age 51.) Engr.-Mgr., Board of County Road Commrs., Wayne County, Mich.; County Highway Engr. Refers to G. C. Dillman, G. H. Fenkell, L. M. Gram, L. G. Lenhardt, H. E. Riggs, C. S. Sheldon, J. S. Worley.

White, Herbert LeRoy, Assoc. M., Urbana, Ill. (Elected Junior Nov. 15, 1926; Assoc. M. Oct. 26, 1931.) (Age 37.) San. Engr., Univ. of Illinois. Refers to M. L. Enger, W. D. Gerber, G. W. Pickels, J. E. Smith, M. Suter.

From the Grade of Junior

Annick, William Alfred, Jun., Scranton, Pa. (Elected Feb. 23, 1932.) (Age 32.) Draftsman, Bureau of Eng. Refers to A. B. Cohen, S. G. Mastriani, C. M. Roberts, J. L. Vogel, F. G. Wolfe.

Booker, James Lester, Jun., Little Rock, Ark. (Elected Aug. 17, 1936.) (Age 32.) Res. Engr., Arkansas State Highway Dept. Refers to W. E. Ford, G. L. Fry, R. C. Gibson, W. H. Marak, J. M. Page, W. W. Zass.

Camp, Fred Albert, Jun., Bishop, Calif. (Elected Oct. 26, 1931.) (Age 32.) Jun. Civ. Engr., Dept. of Water & Power, City of Los Angeles, Calif., Mono Basin Project. Refers to E. A. Bayley, H. P. Bliss, N. M. Imbertson, H. L. Jacques, L. C. Rogers, A. E. Sedgwick, W. W. Wyckoff.

Easterbrooks, Preston Burt, Jr., Jun., Anniston, Ala. (Elected March 26, 1934.) (Age 32.) Plant Engr., Monsanto Chemical Co. Refers to H. P. Burden, G. W. Burpee, R. W. Lefavour, F. N. Weaver, E. H. Wright.

GAMMAGE, CHARLES EDWIN, Jun., Birmingham, Ala. (Elected Dec. 5, 1927.) (Age 32.) Constr. Foreman, Tennessee Coal, Iron & R.R. Co. Refers to L. F. Bellinger, R. P. Black, A. J. Cooper, C. R. Hopper, H. B. Pope.

GOTAAS, HAROLD BENNEDICT, Jun., Chapel Hill, N.C. (Elected July 14, 1930.) (Age 31.) Asst. Prof. of San. Eng., Div. of Public Health, Univ. of North Carolina. Refers to T. R. Agg, H. G. Baity, J. M. Brown, R. A. Caughey, G. M. Fair, A. H. Fuller.

GRAVES, QUINTIN BRANSON, Jun., Austin, Tex. (Elected Jan. 28, 1935.) (Age 32.) Instructor, Univ. of Texas. Refers to N. W. Dougherty, F. W. Epps, J. A. Focht, J. H. Kimball, B. J. Lambert, W. C. McNown, E. L. Waterman, S. M. Woodward.

HOFFMAN, IRVING CHARLES, Jun., Riverside, Calif. (Elected Oct. 30, 1933.) (Age 32.) Engr., Griffith Co., Los Angeles, Calif. Refers to G. H. Dunstan, R. M. Fox, W. J. Fox, L. W. Irwin, A. L. Sonderegger.

MCMILLEN, DALE STEINER, Jun., Coulee Dam, Wash. (Elected Nov. 23, 1931.) (Age 32.) Asst. Engr., U. S. Bureau of Reclamation. Refers to F. A. Banks, B. A. Hall, L. V. Murrow, H. E. Phelps, M. K. Snyder, J. G. Woodburn.

MARIN, JOSEPH, Jun., New Brunswick, N.J. (Elected March 11, 1929.) (Age 32.) Asst. Prof. of Eng. Materials, Rutgers, Univ. Refers to G. E. Beggs, H. Cross, W. C. Huntington, H. N. Lendall, W. M. Wilson.

PAGE, NOLAN, Jun., Iowa City, Iowa. (Elected Jan. 14, 1929.) (Age 32.) Associate Engr. and Asst. Engr. in Chg. of Sub-office, U. S. Engr. Office. Refers to F. M. Dawson, J. W. Howe, B. J. Lambert, E. W. Lane, G. E. Lyon, R. H. Matson, F. T. Mavis.

PEEL, KENNETH PERCIVAL, Jun., San Pedro, Calif. (Elected Oct. 14, 1930.) (Age 32.) Asst. Civ. Engr. (acting as Res. Engr.), U. S. Engr. Office. Refers to J. C. Greely, D. E. Hughes, D. W. Morrison, G. F. Rogers, J. L. Stacer, G. F. Whittemore.

PROCUNIAR, ROBERT WILLIAM, Jun., Dayton, Ohio. (Elected Feb. 19, 1934.) (Age 32.) Engr.-Inspector, Eng. Div., city of Dayton. Refers to G. F. Baker, C. S. Bennett, E. O. Brown, F. J. Cellarius, C. H. Eiffert, W. W. Morehouse.

SERVER, JOHN MARKLEY, JR., Jun., Glendale, Calif. (Elected March 5, 1928.) (Age 32.) Senior Draftsman, Right-of-Way Dept., Los Angeles County Flood Control Dist., Los Angeles, Calif. Refers to A. B. Collins, J. H. Freeman, H. E. Hedger, A. Jones, O. de la V. Keese, A. S. Kemman, F. W. Pore.

STEVES, BERT FRANCIS, Jun., Kansas City, Mo. (Elected Oct. 26, 1931.) (Age 32.) With Black & Veatch, Cons. Engrs. Refers to E. B. Black, J. F. Brown, E. H. Dunmire, W. G. Fowler, E. A. Hardin, N. T. Veatch, Jr.

WORLEY, STEWART EARL, Jun., Baton Rouge, La. (Elected Oct. 1, 1928.) (Age 32.) Eng. Aide, Corps of Engrs., U. S. Army. Refers to G. N. Cox, M. E. James, E. G. Paulet, B. W. Pegues, F. F. Pillet.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1937 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

CONSTRUCTION

CIVIL-CONSTRUCTION ENGINEER; Jun. Am. Soc. C.E.; 30; B.S. in C.E., 1930; single; 5 years experience with private, federal, state, and municipal organizations on design and construction of highways, bridges, dams, and kindred concrete structures; surveying; earthwork. Available on short notice. Will go anywhere. C-238.

SUPERINTENDENT OR ASSISTANT; Affiliate Am. Soc. C.E.; experienced heavy construction, earth and rock excavation on land and under water, foundations, tunnels, retaining walls, timber structures, cofferdam, and unwatering. Has had benefit of working for unusually qualified engineers on big jobs. C-240.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 42; single; college graduate. Extensive all-round designing and construction experience in varied types of buildings and railroad structures, both reinforced concrete and steel. Speaks German. Permanency more important than high salary. Prefers California, but will go elsewhere. Available immediately. C-244-3712, A-4 San Francisco.

CONSTRUCTION ENGINEER; Assoc. M. Am. Soc. C.E.; 34; married; university graduate; licensed professional engineer; 9 years construction experience on projects as engineer and superintendent on location, design, and construction of highways, buildings, and drainage, flood control, sewer and water systems; topographical mapping. Available immediately. Will go anywhere. C-254.

EXECUTIVE

CIVIL ENGINEER WITH ELECTRICAL TRAINING; Assoc. M. Am. Soc. C.E.; 45; married. Last 3 years on appraisal of transmission and distribution lines and depreciation studies; recently on layout and development of underground conduit and cables for primary and secondary system in large city. Available now. Registered in Pennsylvania. C-237.

ENGINEER-ACCOUNTANT; Assoc. M. Am. Soc. C.E.; 46; 12 years on design and construction, bridges, buildings, subways, etc.; 13 years construction and public utility accounting, examination of state, municipal, and corporate accounts, costs, loans, and grants, acquisition of properties, organization of subsidiaries, system, mergers, accounting control, and general administration; 2 years in Spanish-America. Now available. C-241.

CIVIL ENGINEER, CONSULTING ENGINEER; M. Am. Soc. C.E. Over 25 years experience. Formerly assistant chief engineer of one of the largest building construction companies in the United States. As consulting engineer he has made reports on building programs and on engineering organizations involving hundreds of millions of dollars. Wishes to serve as director or consultant on large building projects. C-247.

ASSOCIATE TO CONSULTANT OR ARCHITECT; Assoc. M. Am. Soc. C.E.; B.S.C.E., Armour Institute of Technology; chief civil engineer for fabricator, contractor, manufacturer, public utility. Chance to obtain services of high-grade man; 20 years unusually broad experience, design and construction of public works, commercial and industrial buildings, and bridges. Excellent recommendations; professional license. Interested in permanent connection only. C-253.

JUNIOR

CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 27; B.S.C.E., George Washington University; building construction; transitman and drafting; desires position with bridge building company or surveyor's job. Willing to go anywhere. Has had experience in the tropics. Available immediately. C-239.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E., University of Illinois, 1936. Now employed; desires change to job with better opportunity for experience and advancement. Hydraulic or survey work preferred. Experience, 1 1/2 years in highway department; 2 months with private engineer (survey work). Will go anywhere in the United States. C-243-9297 Chicago.

ASSISTANT CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; M.C.E., Rensselaer Polytechnic Institute; member Sigma XI; some business administration, finance, and law; 4 years experience as construction engineer on sewage treatment, water works, highways; 2 years experience on design of steel and concrete structures, utilities, power transmission, and distribution. Location in the United States. Available on short notice. C-242.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; C.E. degree, Cornell University; 32; single; 2 1/2 years as transitman; 1 1/2 years as assistant engineer, W.P.A.; 2 1/2 years as lieutenant, CCC; 1 1/2 years diversified experience. Free to travel; available immediately; desires permanent connection. C-245.

UNIVERSITY GRADUATE; Jun. Am. Soc. C.E.; 25; desires either domestic or foreign employment with permanent connections. Has had 3 years heavy construction work, including 18 months as chief of party on surveys. Excellent references. Available on short notice. C-248.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; single; B.S.C.E., University of Michigan, 1935; 6 months as instrumentman; 13 months as assistant operator and operator, Sperry Rail defect-detector car, examining and diagnosing defects of rail in track; 9 months as structural draftsman. Desires opportunity as assistant in engineering or maintenance-of-way department of railroad. Location immaterial. Available on reasonable notice. C-249.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; B.S.C.E., University of Illinois, 1933; 8 months as draftsman; 3 months as construction inspector; 3 months as assistant construction superintendent; 1 year as construction foreman; 3 years as junior engineer for government; 6 months as contractor's engineer; 2 months as appraisal engineer. Location immaterial. Available immediately. C-251.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S. in C.E., Massachusetts Institute of Technology, 1934; 1 year drafting, simple designing of reinforced concrete in engineering department of park district; over 1 year field and office work with Corps of Engineers on dam on upper Mississippi River. Employed but project completed; free to go anywhere. C-252.

CONCRETE ENGINEER; Jun. Am. Soc. C.E.; 26; married; member of American Concrete Institute; B.S.C.E.; Tau Beta Pi; 1 1/2 years experience on concrete inspection; 3 1/2 years concrete testing, design, control, and research. Location immaterial. Desires position as concrete engineer, concrete technician, or assistant. C-255.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S.C.E., Rose Polytechnic Institute, 1936; 1 1/2 years experience as engineer in railway maintenance department, both office and field work; desires position in construction or sanitary engineering. Will travel anywhere; available at once. C-256.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate of approved university, class of 1937; would like any work of engineering nature, office or field, anywhere in the United States to begin professional career. Single; 21; excellent health; scholastic record; and references. At present unemployed and located in Boston. C-257.

MISCELLANEOUS

TRAFFIC ENGINEER; Assoc. M. Am. Soc. C.E.; associate member of Institute Traffic Engineers; 29; married; B.S. and M.S. in C.E., University of Illinois (traffic engineering major); 3 years in responsible charge of traffic surveys; 3 years as office engineer for traffic organization of Mid-Western state. Experienced in both city and rural traffic problems. Available on short notice. C-250.

TEACHING

PROFESSOR OF CIVIL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; 48; M.S. in C.E.; registered professional engineer; 5 years civil engineering practice, largely structural design and surveying; 20 years continuous teaching in structures, mechanics, materials, surveying, and drafting. Administrative and executive experience. Now employed. Will consider change. C-246.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 77 of the Year Book for 1937. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

(The) **Administration of Federal Grants to States.** By V. O. Key, Jr. Published for the Committee on Public Administration of the Social Science Research Council by Public Administration Service, Chicago, 1937. 388 pp., tables, 9 × 6 in., cloth, $3.75.

One of a series of studies of the administrative problems of the social security program, this book is limited strictly to an examination and analysis of administrative practices, policies, and problems from several federal agencies and jointly financed state activities. Larger questions of public policy in connection with grants-in-aid have been omitted.

A.S.T.M. Standards on Cement, prepared by Committee C-1 on Cement. Specifications, Chemical Analysis, Physical Tests. Philadelphia, American Society for Testing Materials, 1937. 96 pp., illus., diagrs., charts, tables, 9 × 6 in., paper, $1.

The standard specifications and methods of testing are brought together in one publication, together with a manual on cement testing. The purpose of the latter is to emphasize the factors that affect the results of tests and to call attention to less apparent influences that are sometimes overlooked. There is a bibliography on portland cement.

Book of A.S.T.M. Tentative Standards 1937. Philadelphia, American Society for Testing Materials, 1937. 1629 pp., diagrs., charts tables, 9 × 6 in., paper, $7.

This annual list of tentative specifications, methods of testing, definitions of terms, and recommended practices covers materials of engineering and the allied testing field, proposed by the American Society for Testing Materials.

Elementary Theory of Operational Mathematics. By E. Stephens. New York and London, McGraw-Hill Book Co., 1937, 313 pp., tables, diagrs., 8 × 6 in., cloth, $3.50.

The object of this book, which is an extension of the fundamentals of Heaviside's work in operational mathematics, is to describe the simplification of the operators in differential and integral calculus by algebraic methods, and to reinterpret the resulting forms to operators for easier handling. Useful formulas and brief historical material are given in appendixes, and a large bibliography is included.

(The) **Engineers' Who's Who**, 1937, compiled by M. E. Day. London D.M.A. Co., Ltd. 1937. 183 pp., 9 × 6 in., cloth, 20s.

A biographical directory of 1,300 men of importance in the engineering field, covering Great Britain and Ireland.

(The) **Flow of Homogeneous Fluids Through Porous Media.** By M. Muskat, with an introductory chapter by R. D. Wyckoff. New York, McGraw-Hill Book Co., 1937. 763 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $8.

In this comprehensive treatment of the subject, all typical problems of practical interest, with particular stress on illustrations of the various analytical methods available for solving flow problems, are covered. It is hoped that the book will be of value in the study of conditions met with in oil production, hydrology, irrigation, dam construction, and similar fields. Summaries containing the quantitative results are given for most of the chapters, and there is an appendix summarizing the whole book.

(The) **Formation of the New England Railroad Systems.** By C. P. Baker. Cambridge, Mass., Harvard University Press, 1937. 283 pp., maps, charts, diagrs., 9 × 6 in., cloth, $3.50.

A comprehensive, detailed account of the growth and acquisitions of the principal New England railroads from about 1840 to 1900 is given in this volume. The introduction discusses briefly the physical and economic geography and the economic history of New England for this period. The object of the book is to present a historical background for a consideration of contemporary problems of and forces behind railroad combinations in New England.

Great Britain. Dept. of Scientific and Industrial Research and Ministry of Transport. **Road Research** Technical Paper No. 2. London, His Majesty's Stationery Office; New York, British Library of Information, 1937. 36 pp., illus., diagrs., charts, tables, 10 × 6 in., paper, 35 cents.

The first and second of these technical papers deal with the resistance of the road surface to skidding and give the results of measurements of the friction resistance of various surfaces under different weather conditions. "Braking force coefficients" are given in the present report, which also contains certain "laws of road friction" formulated from the data that have been assembled. It also presents a more accurate method for calculating the stopping distance of a braked vehicle.

Ground Water. By C. F. Tolman. New York and London, McGraw-Hill Book Co., 1937. 593 pp., illus., diagrs., charts, tables, maps, 9 × 6 in., cloth, $6.

This treatise aims to supply coordinated scientific data regarding the occurrence, motions, and activities of subsurface water. It is said to be the first general treatise on the subject published in English and the only one that summarizes the results of the intensive study of subsurface water in the western part of the United States. The book includes the results of extended practical experience.

How to Use Pictorial Statistics. By R. Modley. New York and London, Harper and Brothers, 1937. 170 pp., illus., diagrs., charts, maps, tables, 10 × 6 in., cloth, $3.

The technique of producing pictorial charts s presented clearly and practically in this handbook, which gives the methods devised by Dr. Otto Neurath of Vienna that are continually increasing in popularity. There is a select bibliography on pictorial statistics.

Hydro- and Aero-Dynamics. By S. L. Green. London, Sir Isaac Pitman and Sons, Ltd.; New York, Pitman Publishing Corporation (2 West 45th Street), 1937. 189 pp., diagrs., $8^1/_2 \times 5^1/_2$, cloth, $3.50.

This book, which is based on courses of lectures given during the past eight years at Queen Mary College (University of London), has been written with the object of providing for students of aeronautics and physics, as well as for those whose nterests are mainly mathematical, an introduction to the theory of the motion of fluids. Modern developments are included.

Indian Water Power Plants, a companion volume to *Hydro-Electric Installations of India.* By Shiv Narayan. Published by Brij Narayan, Poona Electric Supply Co., Ltd., Ganeshkhind Road, Poona 5, India, 1937. 172 pp., illus., maps, tables, 10 × 7 in., cloth, Rs. 5.

Descriptive information concerning hydroelectric plants and projects of the past decade in India and Burma is given here. This is geographically divided, showing the progress and present position of Indian hydroelectric power. The information is supplementary to that contained in an earlier book on this subject by the same author.

Kempe's Engineer's Year Book, 1938, 44 ed. Revised by L. St. L. Pendred. London, Morgan Bros., Ltd., 1938. 2816 pp., illus., diagrs., charts, tables, 7 × 5 in., cloth, 31s. 6d.

This annual British publication covers modern practice in civil, mechanical, electrical, marine, gas, aero, mine, and metallurgical engineering. It contains formulas, rules, tables, data, and memoranda. There are also sections on patents, depreciation, legal questions, and costs. At the end there are some 200 pages of descriptions of particular pieces of equipment of all kinds.

Manual of A.S.T.M. Standards on Refractory Materials, prepared by Committee C-8 on Refractories. Philadelphia, American Society for Testing Materials, 1937. 180 pp., illus., diagrs., charts, tables, 9 × 6 in., paper, $1.25.

This manual gives the latest form of all the specifications, test methods, and definitions in this field, which have been developed by the Society. In addition, it includes detailed methods for the interpretation of test data, surveys showing the service conditions of refractories in important consuming industries, and tables of the composition of the standard samples supplied by he Bureau of Standards.

Motorways, Flyovers, and Mountain Roads. By F. G. Royal-Dawson. London, E. & F. N. Spon; New York, Chemical Publishing Co., 1938. 176 pp., diagrs., charts, tables, 8 × 5 in., leather, 8s. 6d. ($3.50).

This companion volume to the author's *Elements of Curve Design* and *Road Curves* deals with motorways as distinguished from ordinary arterial roads, including many types of junctions and intersections for high-speed traffic, and supplies detailed calculations for the design and setting-out of grade separations, horseshoe curves, and mountain curves in various situations.

National Association of Railroad and Utilities Commissioners. Proceedings of the 49th Annual Convention, Aug. 31, Sept. 1, 2, and 3, 1937. New York, State Law Reporting Co., 1937. 574 pp., illus., maps, tables, 9 × 6 in., cloth, $6.

In addition to the proceedings of the convention, the discussion of the following topics is published: The regulation of electric, gas, and telephone companies; regulation of public utilities' securities and accounting practices; federal motor carrier act; rural electrification; and the railroad situation in general.

Parkways and Land Values. By J. Nolen and H. V. Hubbard. Cambridge (Mass.), Harvard University Press, 1937. 135 pp. illus., diagrs., charts, maps, tables, 10 × 7 in., cloth, $1.50.

A report on the effect of parkways on the communities served, contrasting this effect with that produced by other types of traffic arteries, constitutes this volume. The parkways of Boston, Kansas City, and Westchester County are considered in detail in the search for facts on which to base the economic significance of the parkway.

Proceedings of the American Road Builders' Association. Edited by Charles M. Upham and others. Washington, D.C., American Road Builders' Association (National Press Building), 1937. 827 pp., illus., tables, diagrs., charts, 9 × 6 in., leather, $10.

This complete and concise volume comprises the proceedings of the thirty-fourth annual convention of the American Road Builders' Association, held in New Orleans, La., January 11–15, 1937. The very latest information on standards, methods, materials, and equipment as well as on highway planning, financing, administration, and legislation is given.

Prüfung im Laboratorium und Erfahrung mit Einstoff-, Zweistoff- und Wärmebehandelten Schienen. By M. Roš and A. Eichinger. (Sonder-Abdruck aus dem Berichte der III. Internationalen Schienentagung, Budapest, 8–12 September 1935.) Budapest, Ungarischen Verband für Materialprüfung, 1936. 21 pp., illus., diagrs., charts, tables, 12 × 8 in., paper, apply.

This report gives the results of rail tests at the Swiss Federal Laboratory for Testing Materials, and of the results of practical trial use. Rails consisting of one and of two metals, both of natural hardness, and heat-treated rails were investigated.

Statically Indeterminate Frameworks. By Thomas F. Hickerson. Chapel Hill, N.C., University of North Carolina Press, 1937. 205 pages, $8^1/_2$ × 11 in., cloth, $3 postpaid.

This book deals primarily with the analysis of bending stresses in bridge and building frames, introducing the novel procedure of applying the actual degree-of-fixation at the ends of the loaded members of the structure. It contains more than 300 illustrative drawings and 84 full-page tables of coefficients and beam properties, and is designed to be serviceable both as a text and as an office manual for civil engineers and architects.

Statistical Year Book of the World Power Conference No. 2. Edited by F. Brown. London, World Power Conference; American Committee, World Power Conference, Interior Bldg., Washington, D.C., 1937. 132 pp., tables, 11 × 9 in., cloth, 20s.

Statistics of the resources, production, stocks, imports, exports, and consumption of power and power sources in all countries from which information was available, mainly for 1934–1935, are given here. Power sources are divided into five classifications: solid fuels, liquid fuels, gaseous fuels, water power, and electricity.

Symposium on Corrosion Testing Procedures, held at the Chicago Regional Meeting, American Society for Testing Materials, March 2, 1937, continued at the 40th Annual Meeting, July 1, 1937. Philadelphia, American Society for Testing Materials, 1937. 131 pp., illus., diagrs., charts, tables, paper, $1.25; cloth, $1.50.

This pamphlet contains seven papers upon the problems of corrosion testing, with discussions. The papers discuss the principles of corrosion testing; atmospheric corrosion testing; salt-spray testing; and electrical resistance method of determining corrosion rates; alternate-immersion and water-line tests; standardizing liquid corrosion tests; and soil-corrosion testing.

Timber Products and Industries. By N. C. Brown. New York, John Wiley & Sons, 1937. 316 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.50.

About one-half of the total volume of wood harvested each year in America consists of other products than lumber. This volume is concerned with the harvesting of these products and their utilization by conversion into useful commodities. The production of cross-ties, posts, and shingles, of distillation products and naval stores, of boxes and barrels, and of excelsior and wood flour is described. There is a bibliography.

(The) **Towers of New York**, the Memoirs of a Master Builder. By L. J. Horowitz. New York, Simon and Schuster, 1937. 277 pp., illus., 9 × 5 in., cloth, $2.25.

As president of the Thompson-Starrett Building Corporation, Mr. Horowitz played an important part in the erection of many famous buildings in New York and Chicago. His biography is an informal, readable account of his adventures as a contractor.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index 29 Service, West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Canada. Bridge Building, C. R. Young. *Eng. J.*, vol. 20, no. 6, June 1937, pp. 478–498. Semicentennial paper of 50 years of Canadian achievement in engineering and industry. Before Eng. Inst. Canada.

Concrete Slab. Thin Slab Railroad Bridge in Service 24 Years. *Eng. News-Rec.*, vol. 119, no. 23, Dec. 2, 1937, pp. 894–895. Pioneer design and construction of 24-year-old grade-separation bridge carrying branch of Union Pacific Railway over North Main Street in Riverside, Calif.; flat slab deck of 40-ft span has thickness averaging only 22 in. at midspan and 20 in. at supports; four columns carrying slab are connected by belts of reinforcing rods in both directions and on both diagonals.

Floors. Distribution of Wheel Loads and Design of Reinforced Concrete Bridge Floor Slabs, H. R. Erps, A. L. Googins, and J. L. Parker. *Pub. Roads*, vol. 10, no. 8, Oct. 1937, pp. 149–167. Modified formulas for design of bridge slabs with reinforcement parallel or transverse to direction of traffic, giving results nearly the same as those proposed by Westergaard; design of reinforced concrete bridge floor slabs by modified formulas; examples of slab design by modified formulas.

Movable, Electric Control. Operating Movable Bridges, C. P. Hamilton. *Eng. News-Rec.*, vol. 119, no. 21, Nov. 18, 1937, pp. 827–830. Developments in electrical equipment during past 5 years have caused important changes in movable bridge operation; lift bridges using power Selsyn drive; recent lift bridges using variable voltage control; swing-span operation; enclosed control units.

Natural Gas Pipe Lines, River Crossings. New Pipe-Line Bridge Built Across Brazos River. *Gas Age-Rec.*, vol. 80, no. 2, July 22, 1937, pp. 27 and 35. Brief description of bridge at Waco, Tex., suspending main 16-in. line 20 ft above high water; towers 66 ft high; suspension span 520 ft; overall length of bridge 1,054 ft.

Plate Girder, Denmark. Storstroem Railway and Road Bridge, Denmark. *Engineering*, vol. 144, no. 3742, Oct. 1, 1937, pp. 372–373, and 376. Bridge, about 2 miles long, enables train ferry between Orehoved and Masned to be dispensed with; it carries single-line railway track, motor road 18 ft 4½ in. wide, and footpath 8 ft 2½ in. wide; 47 approach spans are alternately of anchor and suspension types; main girders built up of plates 12 ft deep.

Railroad. Reconstruction of Superstructure of Wood Green Flyover Bridge, L.N.E.R. *Ry. Gaz.*, vol. 67, no. 19, Nov. 5, 1937, pp. 779–781. Description of method adopted for replacing, under traffic, 146-ft continuous girders spanning L.N.E.R. main lines at 40-deg skew, with three separate 49-ft spans, at bridge No. 31.

Railroad, Denmark. Storstrom Bridge. *Ry. Gaz.*, vol. 67, no. 17, Oct. 22, 1937, pp. 691–696. New 2-mile Danish road and rail bridge forming important link in international route between Germany and Denmark, consists of 50 spans rising from each end on gradient of 1 in 150 to middle of stream where three navigation spans give clear headway of about 80 ft for shipping; main girders of high tensile Chromador steel have minimum tensile strength of 82,000 lb and minimum yield point of 51,000 lb per sq in.

Railroad, Maintenance and Repair. Wrought Iron Again to Rescue. *Ry. Eng. & Maintenance*, vol. 33, no. 12, Dec. 1937, pp. 898–900. Troubled with severe brine drip corrosion of top angles of deck stringers of long bridge over the Ohio River at Kenova, the West Virginia, Norfolk & Western Railroad has welded wrought-iron cover plates to tops of all of stringers affected, stopping further corrosion and stiffening top flanges at same time; work, which involved 3,381 lin ft of plates and 6,762 lin ft of fillet welds, and which was done without delays to traffic, is described.

Railroad Structures. Bridge and Building Convention. *Ry. Eng. & Maintenance*, vol. 31, no. 11, Nov, 1937, pp. 801–837. Committee reports before American Railway Bridge and Building Assn., Oct. 19–21, dealing with improvements in organization, maintenance of movable bridges, deferred maintenance painting, developments in trestle construction, safety in use of power tools, fire protection demands for water service, and insulation of railway buildings, etc.

Steel. Kentucky Builds Record Bridge, E. D. Smith. *Eng. News-Rec.*, vol. 119, no. 17, Oct. 21, 1937, pp. 672–673. Features of Capital Memorial Bridge, now under construction over Kentucky River in Frankfort, Ky., consisting of three-span continuous steel deck-girder unit, 474 ft long, believed to be the longest in the United States.

Steel, Wrecking. Removing Submerged Steel by Blasting, L. Grover. *Eng. News-Rec.*, vol. 119, no. 19, Nov. 4, 1937, p. 758. Use of exploding charges, sunk in metal tubes, to break up truss members of flood-wrecked bridge at Manhattan, Kans.; arrangement of dynamite charges whose explosion severed steel member and permitted its removal.

Suspension. Erecting Suspended Steel. *Western Construction News*, vol. 12, no. 5, May 1937, pp. 169–170. Use of safety net saves 12 men from falls during steel erection; four travelers used in erecting steel; riveting.

Suspension, Cables. Golden Gate Bridge Cables Spun at Record Speed Using New Methods, B. Birdsall. *Western Construction News*, vol. 12, no. 5, May 1937, pp. 164–168. Special methods developed for placing total of 21,392 tons of wire at maximum rate of 708 wires, or 276 tons per cable, in 8-hour period; new equipment and procedure; principles of cable spinning; handling wire; control of operations; compacting.

Suspension, Golden Gate. Driving Waldo Approach Tunnel. *Western Construction News*, vol. 12, no. 5, May 1937, pp. 171–174. Building of 4-lane, 1,000-ft tunnel for approach to Golden Gate Bridge; driving method included use of 3 drifts, ring stopping, and temporary steel rib supports; tunnel design; major equipment; concreting; removal of core.

Viaducts, Concrete. Novel Concrete Towers Support Steel Girders, F. E. Bates. *Ry. Age*, vol. 103, no. 20, Nov. 13, 1937, pp. 674–676. Adaptation of 24-in. reinforced concrete pile developed by Missouri Pacific, employed extensively in construction of 3-pile bents for trestles, has been applied recently in form of tower or bent for support of 55-ft girder spans in two viaducts; object is to extend application of concrete bent construction to locations where height of structure is such as to preclude use of reinforced concrete pile bent.

Viaducts, Steel. Rigid-Frame Rocker Bents, C. D. Geisler. *Eng. News-Rec.*, vol. 119, no. 22, Nov. 25, 1937, pp. 868–871. Design and construction of Blue Ridge Parkway viaduct, 235 ft total length, characterized by rigid-frame rocker bents, continuous I-beam deck, and cast-steel finger-type expansion joint; foundations; quantities and equipment.

Wooden, Standards. Report of Committee VII—Wood Bridges and Trestles. *Am. Ry. Eng. Assn.—Proc.*, vol. 38, 1937, pp. 183–186, (discussion) 624–629; 10 supp. sheets. Design of wood trestles for heavy loading; bearing power of wood piles, with recommendation as to methods of determination; recommended relationships between energy of hammer and weight or mass of pile for proper driving, to include concrete piles; improved design of timber structures to give longer life and lower cost of maintenance.

BUILDINGS

Codes. History of Building Regulations, G. N. Thompson. *Bldg. Standards Monthly*, vol. 6, no. 10, Oct. 1937, pp. 11–14. Historical review of regulation of buildings from ancient times to present.

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